Popular Science Monthly

Most Wonderfully Illustrated Magazine in the World

OCTOBER, 1924; Vol. 105, No. 4
25 cents a Copy; $2.50 a Year

Published in New York City at
250 Fourth Avenue

Coming Next Month

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The wide choice of receiving sets and hookups available, varying widely in cost, operation, and results for different localities, has brought about a serious problem for every person who is eager for the best that radio offers within his means.

To help you solve your individual radio problem and to keep you abreast of radio progress—these are the main purposes of POPULAR SCIENCE MONTHLY's enlarged Radio Section, the most complete and useful of its kind published in any magazine.

In this section next month, for example, an expert of the POPULAR SCIENCE INSTITUTE OF STANDARDS will tell you how to choose the set within your means that will give you the best service in your locality. Milton B. Sleeper, one of America's foremost radio engineers, will describe how you can build a short-wave receiver to pick up short-wave transmission that cannot be heard with the ordinary receiver. Jack Binns will give you all the up-to-the-minute radio news.

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The magic stuff called electricity.—What it will do for you, and what science is doing to enlarge its powers as your servant. Edward Mott Woolley's remarkable story of a tremendous laboratory where men are harnessing its mysterious forces for the benefit of mankind.

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And more than 200 other fascinating articles and pictures giving you all the news of science and invention, strange and unusual things people are doing, together with practical ideals for the automobile, the home, the home workshop, and the use of tools and machinery.

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H. J. Fisher, *President;* R. C. Wilson, *Vice-President;* O. B. Capen, *Secretary and Treasurer*

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Making More Money Than The Boss

If you think it can't be done then there is a surprise in store for you.

THERE is one profession, and only one, in which the Boss often makes less money than some of the men under him. And you can—but read the remarkable letter below, received a short while ago by the National Salesmen's Training Association from a Sales Manager who was investigating this System of Training, with a view to increasing his own efficiency.

The record of this student is in the Association files, but it is no different than hundreds of other really amazing records of inexperienced men who have studied this wonderful System of Salesmanship Training.

Why Salesmen Are Well Paid

How would you like the opportunity to make more money than the man who employs you? Sounds almost foolish, doesn't it? Yet, the seemingly impossible feat of making more money than the Boss is being done regularly in the selling field. Many salesmen earn more money than the man or men above them. In some cases, they earn far more than the president of the Company.

There is a good reason why the same ability will command a larger income in the selling end of business than in other departments. The men in the shops making the goods, and the men in the office handling routine accounts and credits, can never be as vital to a business as the men out selling — their efforts actually determine how much goods shall be made.

> "I note in your literature the names of some of the boys from Kentucky and Indiana with whom I am well acquainted. One of the boys from Kentucky, by the way, broke in under me. While still a cub, and without my knowledge, he took up the N. S. T. A. Course and it wasn't long before I got a jolt. *His weekly pay checks were even larger than my own.*
>
> "His increased earnings made me question him and it was then he admitted he was studying with you. The fact that he continued to succeed in such a big way caused me to write to you.
>
> "I do not envy this man in the slightest degree, but I do want to say that if your training could develop this particular man into a high-class salesman, as it has, then your course could almost make a wooden Indian into a salesman.
>
> "Had you met this man when I did you would have hesitated about accepting his enrollment. I am free to admit he of all others has taken the conceit completely out of me when it comes to passing judgment on prospective Salesmanship timber."

Irving T. Bush, Founder and President of the Bush Terminal Company in an article in the American Magazine, said:

"Go through any industry and you will find the same grade of intelligence is better paid in the selling force than it is in any other department. To those men who must make money to take care of responsibility and support of family, I again say, 'GO SELL.' And opportunities for selling jobs are ten to one in other fields."

State of Illinois } SS
County of Cook }

I, J. E. Greenslade, President of the National Salesmen's Training Association, of Chicago, Illinois, state under oath, that between January 1st, and June 30th, 1923, this Association received calls for 29,236 Salesmen.

Subscribed and sworn to before me this 12th day of July 1923.

MARY A. McMULLEN NOTARY PUBLIC COOK COUNTY, ILL.

J. E. Greenslade

Notary.

Secrets That Make Master Salesmen

From greenhorn to Star Salesman in next to no time sounds almost too good to be true. Yet, the National Salesmen's Training Association performs this wonderful transformation for thousands year after year because it teaches the *real secrets of salesmanship.*

A. H. Ward returned from France broke, untrained. Last month he earned $1,350 as a salesman. H. D. Miller, another Chicago boy, was making $100 a month as stenographer in July, 1922. In September, 3 months later, he was making $100 a week as a salesman. W. P. Clenny, of Kansas City, Mo., stepped from a $150 a month clerkship into a selling job at $500 a month. He is making $850 a month now. M. V. Stephens, of Albany, Ky., was making $25 a week. He took up this training and now makes five times that much. J. H. Cash, of Atlanta, Ga., exchanged his $75 a month job for one which pays him $500 a month. O. H. Malfroot, of Boston, Mass., stepped into a $10,000 position as a SALES-MANAGER—so thorough is this training. All these successes are due to this easy, fascinating and rapid way to master certain invincible secrets of selling.

Why did these men—farm hands, mechanics, bookkeepers, clerks, railroad men and routine workers in every walk of life—attain such quick success. The answer is as simple as A B C. There are certain ways of doing and saying things in selling—certain ways to approach different types of prospects to get their undivided attention, to stimulate interest — certain ways to overcome objections, batter down prejudices, outwit competition, and make the prospect act. Once you know these vital things—once you have acquired these fundamental principles—big success awaits you in this fascinating field.

Previous Experience Unnecessary

It doesn't matter what you are now doing for a living. If you can read and write and have average intelligence, there is a wonderful future awaiting you in the selling field. If you must make more money, if you want to attain a measure of financial independence, if you want to accomplish worthwhile things, then let us send you all the facts about this remarkable System of Salesmanship Training and Employment Service, including a big, FREE, illustrated book, "Modern Salesmanship."

In this book you will find full details about the National Demonstration Method which gives you actual experience while studying, complete information about the N. S. T. A. System of Electives which enable you to go out and sell a line, fortified with proven plans and successful methods of Master Salesmen in the line or lines you choose to sell. Also tells how N. S. T. A. Free Employment Department helps you to select and secure a position as local or traveling salesman as soon as you are qualified and ready.

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To fill out and mail the coupon below may prove to be the turning point in your career as it has for thousands. It will not obligate you, though it may inspire you to make a move in the direction of bigger pay, more opportunities, and congenial work. Don't hesitate. A good idea to get it into the mail right NOW.

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National Salesmen's Training Association
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Please mail me Free Proof that I can become a Master Salesman and qualify for a good sales position. Also send your illustrated book, "Modern Salesmanship," and particulars of membership in your Association. This is all free of cost or obligation.

Name.....

Address.....

City..... State.....

Age..... Occupation.....

Della Jed

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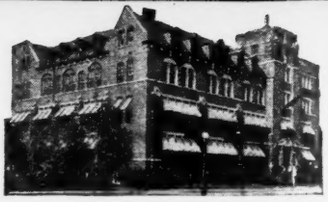

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The American School is not a money-making corporation, but like resident schools and colleges, is chartered strictly as an "Educational Institution, not for profit."

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For over a quarter of a century, Big Engineers, Educators and Business Men have recommended the American School. They know that our long experience as an educational institution guarantees the best training at the lowest possible cost.

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EARN $3500 to $10000 a Year

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When I started your course I was a carpenter never earning more than $7.50 a day. Now, thanks to your training, I make from $30 to $50 a day in business for myself doing electrical work. J. R. Morgan, Columbus, Ohio.

In Business For Himself

L. L. Cooke:

From a $15 a week man I have become a successful electrical contractor. In the last eight months I have cleared more than $450 a month over and above all expenses. I can never thank you enough for what you did for me. Fred Fritschman, 3959 Amundson Ave., New York City.

$9,000 a Year

Everything is going fine now and I am earning about $750 a month. Again I must thank you for my success. It was you and your wonderful course that put me where I am. W. E. Pence, Albany, Oregon.

What's YOUR Future?

Now you earn $20 or $30 or $40 a week. In the same six days as an Electrical Expert you can make $70 to $200 and make it easier — not work half so hard. Why then remain in the small-pay game, in a line of work that offers no chance, no big promotion, no big income? Fit yourself for a "Bossing" job—

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Today even ordinary Electricians—the "screw driver" kind—are making money—big money. But it's the trained man—the man who knows the whys and wherefores of Electricity — the "Electrical Expert" — who is picked to "boss" the ordinary Electricians — to boss the Big Jobs —the jobs that pay.

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You don't have to be a High School Graduate — it isn't even necessary that you should have finished the grades. As Chief Engineer of the Chicago Engineering Works, I know exactly the kind of training you need, and I will give you that training. My Course in Electricity is the most simple, thorough, successful and practical in existence, and offer every man, regardless of age, education or previous experience, the chance to become, in a few short months, an "Electrical Expert" able to make from $70 to $200 a week.

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With me you do practical work—at once. In my first few lessons I show you how to make money doing Electrical work in your spare time. (Over half of my students are paying for their course in this way.) I show you, also, how to get started in business for yourself and then I help you to get started.

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BARGAINS. No. 3½ Garvin Milling Machine, 5.00. 20" Drill press, $50. 13" x 5' Steptoe engine e, $125. Complete line machinery. Cincinnati chinery Supply Co., 217 E. Pearl St., Cincinnati, O.

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WANTED

WANTED: Light Machinery, Lathes, Drill Presses, el High Speed Gasoline and Steam Motors. Best h Prices Paid. Motor Specialties Co., Crafton, Penna.

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To win one of these cash prizes is easy, and every reader is invited to enter this fascinating competition. Just write a letter of not over seventy words answering this question:—

What Advertisement of "Money Making Opportunities" in this issue interests you most and why?

Here are the prizes we will pay for the ten best letters answering the above question:—

First Prize	**$10.00**
Second Prize	**5.00**
Third Prize	**3.00**
And 7 Prizes of $1.00 each	**7.00**

First read every one of the "Money Makint Opportunity" advertisements on pages 6 to 26. Check the ones that interest you. Then read over the ones you have checked and decide on the one that interests you most.

Then write a short letter, not more than seventy words, telling us why the advertisement you pick interests you most. Remember that ten prizes will be awarded. You have a good chance of winning one of them. Be sure to mail us your answer before Oct. 1st. The prizes will be awarded, in the order of their merit, for the letters that are most interesting and best expressed.

The names of all the prize winners and the letters that win the first two prizes will be printed in this column in the December issue. Address your prize letter to

Contest Editor
POPULAR SCIENCE MONTHLY
250 Fourth Ave., New York City

Last Month's Prize Winners

The First Prize of $10.00 goes to Norman Reynolds, Spruce Creek, Pa., for his letter on the advertisement of "Money Making Opportunities." Here is Mr. Reynold's letter:

> Dear Sir:—
> The slogan of a well-known flashlight manufacturer is, "The light that says, 'There it is'." This phrase concisely describes the assistance rendered me by "Money Making Opportunities." Coming at a time when I urgently needed expert chemical assistance, they pointed the way to the Doris Chemical Laboratories and said, "There it is." Naturally I am most interested in this advertisement for it furnished a satisfactory solution to my problem.
> NORMAN REYNOLDS.

Mr. Ralph M. Williams, Amherst, Mass., wins the Second Prize for the following letter regarding the advertisement of the R. J. Carnes Company. Here is Mr. Williams' letter:—

> Dear Sir:—
> I looked over the various advertisements in "Money Making Opportunities" and that of R. J. Carnes attracted me the most. I hope to become a writer of fiction and the writing and reading of manuscripts would let me see the various forms of wording, etc. used by different authors. And then, of course, I could earn a little money toward a college education.
> RALPH M. WILLIAMS.

The Third Prize goes to Carl C. Hill, Glide, Oregon.

The winners of the other seven prizes are:—

Mrs. A. J. Hagel, Hartford, Kans.; Charles M. Reynolds, Spruce Creek, Pa.; J. F. Riley, Wheeling, West Va.; Cornelius D. Vezin, Yonkers, N. Y.; S. D. Snavely, Wytheville, Va.; Mrs. S. M. Passmore, Butte, Mont. E. F. Sauer, Milwaukee, Wis.

Rate 30 Cents a Word. A 10% discount is allowed on all contracts for six consecutive insertions. Advertisements intended for the December issue should be received by October 5th.

RADIO AND SUPPLIES

68 STATIONS on Crystal without tubes or batteries. You fellows who haven't tried my hook-up don't know what you are missing. Write, Leon Lambert, 670 Volutsia, Wichita, Kansas.

2,650 MILES Distance with one tube. Any Novice understands our Simplified Instructions, including Panel Layout and Photo 25c. Vesco Radio Co., Box PS 117, Oakland, Calif.

RADIO tubes, D11, D12, UV199, UV200, UV201A, $4.25. Dutch radio tubes, D12, D200, D201A, $2.50. Crystal set, 50c. Add postage. Radio Sales Co., 1168 North Kingshighway, St. Louis, Mo.

RADIO Generators: 500v 100 watt, $28.50. Battery Charging Generators, $8.50. High Speed Motors. Motor Generator Sets all sizes. Motor Specialties Co., Crafton, Penna.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

TRADE AND TECHNICAL SCHOOLS

$10 TO $20 per day. Practical courses in Sign-Pictorial-Auto Painting—Decorating—Graining—Marbling—Paperhanging—Low Cost—Catalog Free. Chicago Painting School, 157 W. Austin Ave., Chicago, Ill.

CHICAGO Technical College offers short, intensely practical courses in Drafting and Engineering—civil, mechanical, electrical, structural—Architecture, Building Construction, Plan Reading, etc. Courses fitted to your needs. No time wasted. Instructors are experts. Graduates in demand at big salaries. Opportunities for part-time work while studying. Day and evening classes. 21st year. Enter any time. No special preliminary training required. Low tuition—easy terms. Write for 52-page illustrated Blue Book describing opportunities open to our graduates. Chicago Technical College, 23 Chicago Tech. Building, Chicago.

BE a Bricklayer. Attend a school operated by Building Contractors. Three Months Day Course $75.00. Associated Building Employers, 128 A. B. E. Building, Grand Rapids, Mich.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

FOR THE HOME

HOME weaving—looms only $9.90. Big money in weaving rugs, carpets, portieres, etc., at home from rags and waste material. Weavers are rushed with orders. Send for free loom book, it tells all about the weaving business and our wonderful $9.90 and other looms. Union Loom Works, 482 Factory St., Boonville, New York.

GRANDFATHER clock works $5.00. Build your own case, instructions free; make good profits selling your friends. Clock works with chimes for old or new cases. Write for full particulars. Clock Co., Nicetown, Penn.

GASOLINE lamps, lanterns and heaters. Catalog free. Little Wonder Mfg. Co., Terre Haute, Indiana.

BEAUTIFUL child's china cabinet, patterns, instructions 25c. Circular Free. Brogrens Kiddy Kabinets, 2651 8th Avenue, New York.

PURCHASE a beautiful Electric Fountain for your home at Jobber's price. Walter L. Haanel & Co., 4521 Ravenswood Ave., Chicago.

BURN Smoke. Save 20 to 50% of coal. Get cleaner, steadier heat with Crown Fuel Saver. You can quickly attach this inexpensive device to feed door of furnace. Works automatically. Guaranteed to make fuel-saving of at least 20%, or money refunded. Write for booklet and special low price. CFSCO. 14 N. 10th St., Richmond, Ind.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertsing Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Address your inquiry to: Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

MANUFACTURING

DIES, Tools and General Manufacturing. Models and manufacturing of new inventions our specialty. Logan Machine Co., 126 S. Clinton St., Chicago, Ill.

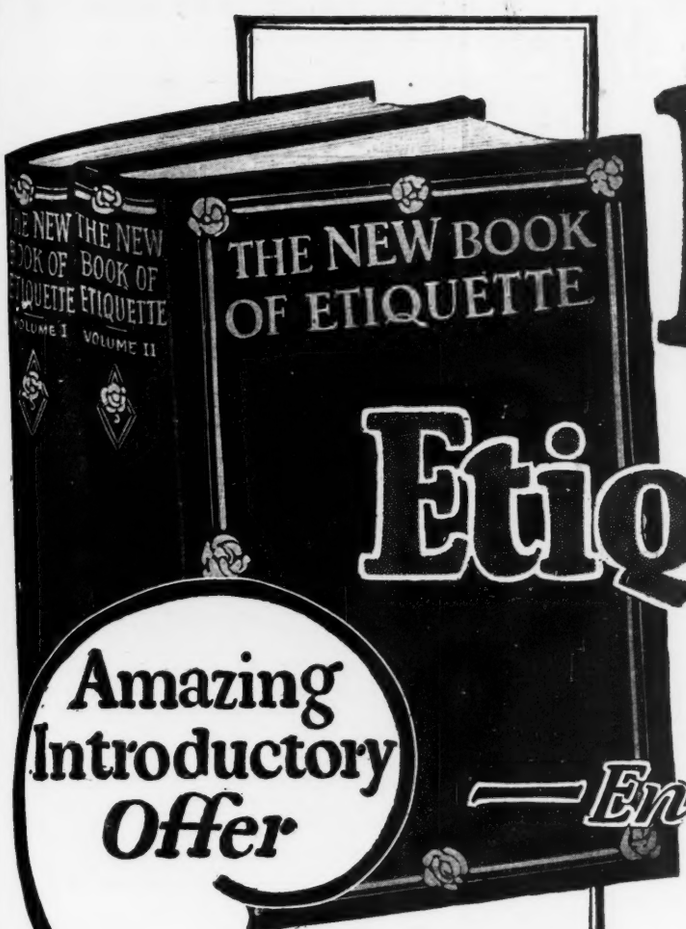
DEVELOPING ideas and manufacturing our specialty. Absolute satisfaction. 33 years' experience; write us. The K. & B. Die & Specialty Co., 2018 Elm St., Cincinnati, Ohio, Dept. C.

AMERICAN MADE TOYS AND NOVELTIES

OPPORTUNITY to start Manufacturing Metal Toys and Novelties. No experience necessary. Enormous demand exceeds supply. We furnish, at cost, casting-forms for production and buy entire output, also place yearly contract orders. Casting forms made to order. Catalog, advice and information free. Metal Cast Products Co., 1696 Boston Road, New York.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Address your inquiry to: Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

More Money Making Opportunities on pages 8 to 26



1925 Etiquette!

New—Unusual —*Entirely Different*

A sane, sensible book of etiquette at last! By the same author whose famous "Book of Etiquette" has sold more than a half-million copies.

HERE is an entirely new kind of etiquette book, based not upon old customs and traditions, but upon *commonsense*. Here is an author who dares to be different, who dares to step out of the beaten track and write an etiquette book intended—not for the so-called "Four-Hundred," not for the man with a butler and a valet, the woman with a twenty-room house and a staff of servants—but for the average man and woman who like occasionally to attend a social function and feel entirely poised and at ease.

For such people, "The New Book of Etiquette" is valuable and important. It is new not only in the sense of being the latest, the most complete and the most up-to-date book of its kind—but it is based upon an entirely new philosophy of manners, created to fill a new need in American life. It is unquestionably the soundest, most sensible and most helpful book on etiquette ever written. So daring in its tearing down of old, outworn traditions that you will be amazed and delighted.

Included in "The New Book of Etiquette" are letters received by the author from all over the world — school teachers, bank presidents, stenographers, senators, day laborers, wives of college professors. A diplomat from India wrote to ask an important question, and the same mail brought a letter from an American living in Panama. The hundreds of questions and actual letters, and the author's answers, are alone worth many times the price of the book. They give you information contained in no other book, information you could not obtain in any other way.

"The New Book of Etiquette" SPECIAL INTRODUCTORY OFFER

This is the kind of etiquette book that is really useful and important, crowded with subjects of daily personal interest, based not upon old rules and regulations but upon new conditions of life. It has been in preparation ever since the original "Book of Etiquette" appeared, and its extraordinary contents have been inspired by the contact the author has had with thousands of readers who confided in her their special little problems.

You must have a copy. Everyone will soon be discussing it. Let us send you "The New Book of Etiquette" in the beautiful, illustrated, first edition—pay the postman only $1.98 (plus few cents delivery charges)—and if you aren't delighted with it, return it to us and the examination will have cost you nothing.

This coupon will bring it to you. Read it and send it off NOW. Nelson Doubleday, Inc., Dept. 2510, Garden City, New York.

Amazing Introductory Offer

The Old Maid Has Vanished!

"The New Book of Etiquette" does not recognize any of the old standards, the outworn traditions. Conditions of life have changed, and this 1925 book of etiquette is written for 1925 conditions. The old maid, for instance. Does she still exist? What has happened to her? Where is she now? What is she doing? How does the new etiquette recognize her?

Need a Tired Man Be Polite?

"The New Book of Etiquette" refuses to accept the stilted formalities of another age than our own. It introduces a fine simplicity that cannot fail to appeal to the intelligent person who has tired of the stiff, formal, artificial manners that ordinary books portray. The new etiquette, for instance, generously forgives the tired, elderly man who remains seated in the crowded subway while raucous-voiced girls swing from the straps in front of him.

—and Slang

Though it has been condemned by almost every writer on etiquette, slang is accepted by "The New Book of Etiquette" which says, "Slang is a characteristic phase of the American language. It can be colourful and expressive without being coarse, and since it adds a typical verve and piquance to our talk, there is no reason why it should be condemned."

Your Copy Is Ready!

A pleasure and surprise awaits you! "The new Book of Etiquette" will justify your greatest expectations. Just the book of etiquette you have always wanted! Send off the coupon—TODAY.

Do You Know—

how to give a trousseau tea?
how to order in a restaurant?
how to plan a formal wedding?
how to adapt yourself to every environment?
how to be socially popular?
how to be at ease in a ballroom?
how to overcome timidity?
how to call on a young woman?
how to propose marriage?
how to cultivate an interesting speaking voice?
how to dress for social occasions?
how to entertain in the latest approved fashion?

NELSON DOUBLEDAY, Inc., Dept. 2510
Garden City, New York

I want to see this attractive, illustrated, first edition of "The New Book of Etiquette," by Lillian Eichler. You may send it to me, complete in the two volumes, and I will give the postman only $1.93 plus few cents delivery charges for this set (which would ordinarily sell for $3.50). It is clearly understood that I am entitled to keep "The New Book of Etiquette" for 5 days, read and examine it and judge it for myself, returning it within that time if I like and having my money refunded. My judgment in this matter is to be final.

Name_____

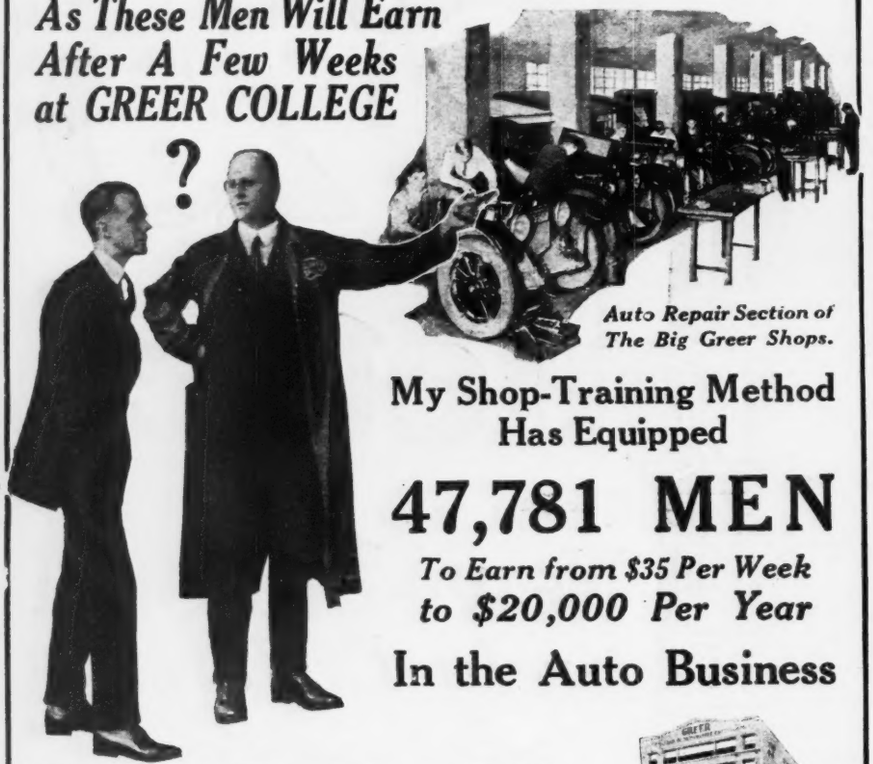
Address_____

City_____ State_____

☐ Check this square if you want these books with the **beautiful full-leather binding** at $2.98 with same return privilege.
(Orders outside the U. S. are payable $2.44 cash with order. Leather binding outside U. S. $3.44 cash with order.)

DO YOU *Earn As Much*

As These Men Will Earn After A Few Weeks at GREER COLLEGE



Auto Repair Section of The Big Greer Shops.

My Shop-Training Method Has Equipped

47,781 MEN

To Earn from $35 Per Week to $20,000 Per Year

In the Auto Business

Special Training Offer

OF the 47,781 men trained in my big Automobile shops, 30,245 are now in business for themselves. Some of these have tire repair shops, some operate battery stations, others own and operate garages, service stations, or sales agencies. All are independent, and earning more money than they had ever earned before taking the Greer Course. In 8 weeks my shop training prepares you to earn $35 to $100 per week, and more as you progress. The same future is *yours* if you will take it. Here is my special offer.

Free Tools—Free Radio Course

When you enroll I furnish you, free, a special kit of tools—23 pieces. For a limited time I will also give you a free RADIO COURSE in connection with your regular automobile subjects.

JOBS GUARANTEED

Rates now reduced. I get you an earn-while-you-learn job immediately if you need assistance. Good-pay Auto jobs GUARANTEED after you are trained. My men are in demand. I can place every man who takes my shop course and takes advantage of the opportunity he is given to thoroughly learn the work.

I PAY RAILROAD FARE

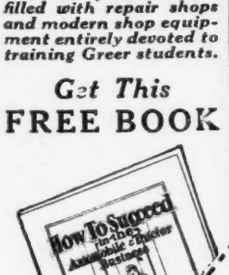
This is a special offer to help you gain the training opportunity that will fit you for a lifetime of big and *better* earnings. Get complete details and study them well before you start.

Mail Coupon For FREE AUTO BOOK

This request brings you my entire proposition and 66 large pages of valuable, illustrated, Auto training information. Mail the coupon to me TODAY!

This magnificent new seven story building is filled with repair shops and modern shop equipment entirely devoted to training Greer students.

Get This
FREE BOOK



GREER COLLEGE
of Automotive Engineering
2024 S. Wabash Ave., Dept. 2402
CHICAGO, ILL.

ERWIN GREER
President
2024 S. Wabash Ave., Dept. 2402, Chicago, Ill.

Please send me FREE BOOK "How to Succeed in the Automobile and Tractor Business," and special training offer. This request does not obligate me in any way.

Name .....

Address .....

.....

Money Making Opportunities

ADVERTISING

ADVERTISE in 24 metropolitan dailies, 24 words, $15.00. Helpful Guide listing 1000 publications, 4c stamps. Wade Company, Baltimore Bldg., Chicago.

28 WORDS in 80 Country Town Newspapers, $3.40. Shaw, 221 A. Northeast, Washington, D. C.

ADVERTISING rates for magazines and weeklies free. Charles A. Lutz, Apartment 241, York, Pennsylvania.

24 WORDS combine list of 70 Sunday and weekly newspapers, $6.00. AdMeyer, 4112 P. Hartford, St. Louis.

ONE Inch in 136 N. Y. Country Weeklies $15. Only one cut needed. The Messenger, Smithtown Branch, Long Island.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

ADVERTISING in all magazines and newspapers at publishers' lowest rates. Sales letters, booklets, folders, planned, written, illustrated. Taylor's Advertising Service, Dept. A, Freeport, Illinois.

FREE Copy Popular Fun Magazine, to advertisers. Fin-Ko, 944-P Clark, Toledo, O.

PRINTING, ENGRAVING AND MULTIGRAPHING

1,000 20 LB. Bond Letterheads, $4.50; 5,000, $16.00; 10,000, $26.00. Other printing reasonable. Get our prices. Few samples Free. A. H. Kraus, Kraus Bldg., Milwaukee, Wis.

BETTER Printing for Less Money. Write us about your printing needs, and you will save money. Ernest Fantus Company, 525 South Dearborn Street, Chicago.

EMBOSSED business, personal stationery. Samples, stamp. Daniels P. Company, Pittston, Pennsylvania.

100 EACH, Letterheads and Envelopes, $1.00. Culpepper Press, Box 85, Faith, Ark.

TRADE-MARKS, letterhead designs, illustrations for advertising. Letters, folders, booklets, written. Quick service, fair prices. Taylor's Advertising Service, Dept. B, Freeport, Illinois.

LETTERHEADS—Hammermill Bond 8½ x 11, 500, $2.65 cash. Other printing. MacDonald Printery, Marietta, Ohio.

225 BOND Letterheads, Envelopes, Billheads, Cards, $1.25 each. Combination $4.00. Economic Printery, Leonia, N. J.

COMMERCIAL Printing. Write requirements. Franklin Press, B-34, Milford, New Hampshire.

GUMMED LABELS

NAME and address, 500, 30c. Others rolls or loose. Stationery, 200 sheets and 100 envelopes printed $1.00. Eastern Label Co., B, Clintonville, Conn.

DUPLICATING DEVICES

STENCIL Duplicating Outfit—$2.00, $3.00, $4.00. Prints Typewriting, Handwriting, etc. On Approval. Primos Specialty Co., 3-X, Primos, Pa.

OFFICE DEVICES

ADDRESSING machines, multigraphs, duplicators, folders, check writers, sealers, dictating machines, at about half new cost. Pruitt, 170-Z North Wells, Chicago.

ADDING MACHINES

FREE trial, marvelous free adding machine. Adds, subtracts, multiplies, divides, automatically. Work equals $350.00 machine. Price only $15.00. Speedy, durable, handsome. Five-year guarantee. Used by largest corporations. Write today for catalog and free trial offer. Lightning Calculator Co., Dept. O, Grand Rapids, Michigan.

TYPEWRITERS AND SUPPLIES

UNDERWOOD Typewriters—only $3.00 down. Easy monthly payments. Low prices at less than manufacturers. 10 days' free trial. Rebuilt, all worn parts replaced. Just like a new machine. 5-year guarantee. Write for big free catalogue, 3707 Shipman-Ward Mfg. Co., 3707 Shipman Bldg., Chicago, Ill.

BRANCH OFFICE SERVICE

PITTSBURGH Office and Representation Free. Pittsburgh Office Service, 973 Union Trust Bldg.

MAILING LISTS

12,000 NAMES Indiana High School Graduates, $3.00—Harvey Morley, Angola, Ind.

G. OXLEY, New Vienna, Ohio, distributes Advertising Matter, and furnishes reliable addresses.

MAILING Lists 99% accurate of individuals, corporations or professions, individually compiled for your needs. Standard charge per thousand names, $4.50. Full particulars and other information free upon request. The Blue Bird Service., 107 East Pleasant Street, Baltimore, Md.

MAIL ORDER BUSINESS

NEW Mail Order Plans, Ideas and Suggestions. In "Business Progress" Magazine Each Month. Sample Copy 10c. 734 Cherry, Kansas City, Mo.

$50 a week, evenings. I made it. Mail order business; booklet for stamp tells how. Sample and plan 25c. Free, 12 articles worth $3. Alps Scott, Cohoes, New York.

ADVERTISE by mail and keep business growing. Let me tell you more. H. J. Reeney, Room 17, Columbia Bldg., Paducah, Ky.

LETTER SPECIALISTS

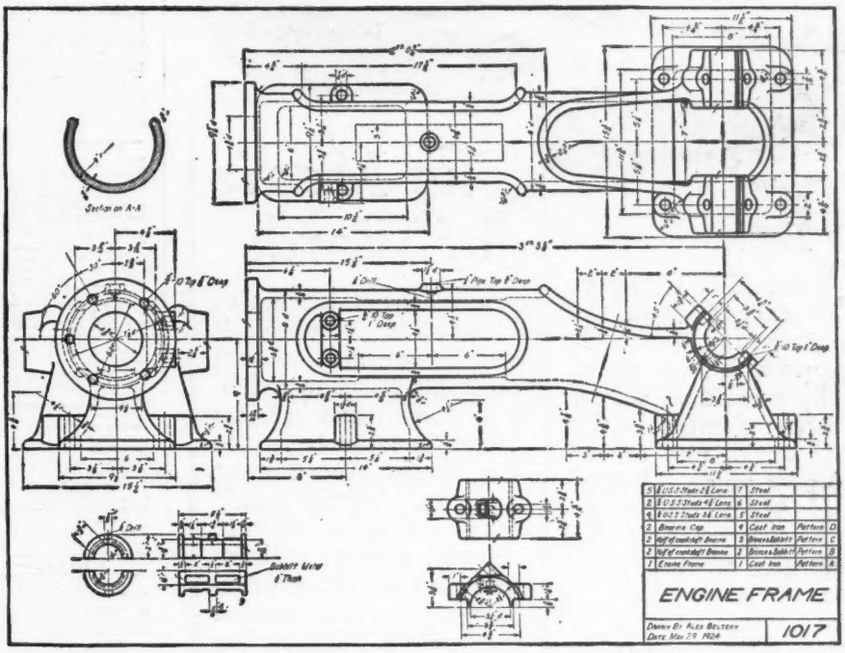
20 SUCCESSFUL Collection Letters $1. Win. 405 Gotham Bank Bldg., New York, N. Y.

THEY have simply got to buy when Prudence sales creators prepare just the kind of selling copy for your sales letters and direct mail campaigns, selling copy that gets your prospects and orders. Send for proof of what we can do for you, and your free copies of Dealing With Human Nature Profitably and Sales Letters Profitable Business Builders. Valuable suggestions for increasing sales will be found in them. The Prudence Advertising Company, 32 Union Square, New York.

LET me write your sales letters, booklets, folders. Wide experence, fair prices, quick service. L. Taylor, Box 44P, Freeport, Illinois

More Money Making Opportunities on pages 6 to 26

We can teach you to make drawings like this



We have more requests for trained draftsmen than for graduates of any other course

THE drawing reproduced above was made by a student of the International Correspondence Schools. It is just one of many hundreds of drawings that our students make every year and shows what any man can accomplish through the I. C. S. Courses in Drafting.

This drawing is not only accurate in construction and well executed, but the shading, the dimension figures and the lettering all show the skillful handling of details so characteristic of the work of first-class draftsmen.

And this student had never seen a bow-pen a few months before!

What we did for this student, we can do for you. It is a mistaken idea that a man must have a talent for drawing in order to succeed as a draftsman. Any student who will study as we direct can learn quickly to make neat, accurate mechanical, structural and architectural drawings.

The Drafting Courses of the International Correspondence Schools are the most practical drafting courses offered to-day. They start at the beginning and lead you forward by easy, understandable steps until you can make the most complicated drawings. It makes no difference if you have never seen a drawing instrument. If you can write, we can teach you to draw.

Write for this
FREE BOOKLET

It tells all about the courses in Drafting offered by the International Correspondence Schools, gives the names and photographs of successful students and tells how you, too, can get a good position in this interesting and profitable field. Just mark and mail the coupon and we'll send you this booklet, *free.*

How to become a draftsman

It is easier than it was a few years ago. Formerly you had to start as blue-print boy, at small pay, and the best you could hope for after a year or so was to be promoted to the work of tracer. Then in another year or two you would be advanced to making detail drawings of comparatively unimportant parts and could call yourself a junior draftsman.

Now the International Correspondence Schools have made it possible for you to study drawing in your own home in your spare time and thus to enter a drawing room, not at the bottom as blue-print clerk, but as draftsman, at a good salary from the start. Mail the coupon for free booklet which explains everything.

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 7616-D, Scranton, Penna.

Without cost or obligation on my part, please tell me how I can qualify for the position or in the subject *before* which I have marked an X:

BUSINESS TRAINING COURSES

☐ Business Management	☐ Salesmanship
☐ Industrial Management	☐ Advertising
☐ Personnel Organization	☐ Better Letters
☐ Traffic Management	☐ Show Card Lettering
☐ Business Law	☐ Stenography and Typing
☐ Banking and Banking Law	☐ Business English
☐ Accountancy (including C.P.A.)	☐ Civil Service
☐ Nicholson Cost Accounting	☐ Railway Mail Clerk
☐ Bookkeeping	☐ Common School Subjects
☐ Private Secretary	☐ High School Subjects
☐ Spanish ☐ French	☐ Illustrating

TECHNICAL AND INDUSTRIAL COURSES

☐ Electrical Engineering	☐ Architect
☐ Electric Lighting	☐ Architects' Blue Prints
☐ Mechanical Engineer	☐ Contractor and Builder
☐ Mechanical Draftsman	☐ Architectural Draftsman
☐ Machine Shop Practice	☐ Concrete Builder
☐ Railroad Positions	☐ Structural Engineer
☐ Gas Engine Operating	☐ Chemistry ☐ Pharmacy
☐ Civil Engineer	☐ Automobile Work
☐ Surveying and Mapping	☐ Airplane Engines
☐ Metallurgy ☐ Mining	☐ Agriculture and Poultry
☐ Steam Engineering ☐ Radio	☐ Mathematics

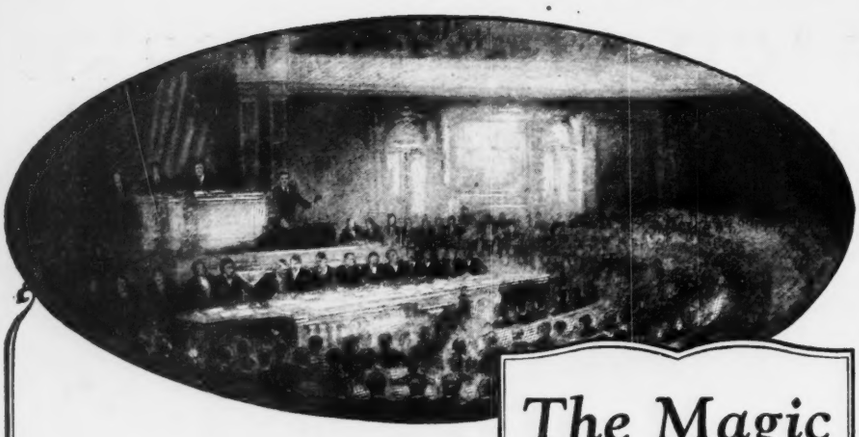
Name.....

Street Address..... 3-6-24

City..... State.....

Occupation.....

Persons residing in Canada should send this coupon to the International Correspondence Schools Canadian, Limited, Montreal, Canada



Free—1924 Reference Atlas

You may have the 1924 edition of the "New Reference Atlas of the World" without a penny of cost. It contains 148 pages with 96 pages of maps, beautifully printed in colors, including all recent changes in the countries of the world, new census figures, parcel post guide. Bound handsomely; size 9⅝ x 12½ inches. This splendid Atlas is included *free* in our special offer to new subscribers for

WEBSTER'S NEW INTERNATIONAL DICTIONARY

The Merriam Webster

The "supreme authority"—a complete reference library in dictionary form—one big, convenient volume, the type matter of which is equivalent to a 15-volume encyclopedia.

Thousands of new words that have only recently come into use; 407,000 vocabulary terms; a biographical section giving information about 12,000 famous men and women; 32,000 geographical subjects; over 6,000 illustrations; answers all your questions about words, people, places and things. On approved orders this valuable work will be

Delivered for $1.00

and the balance of the price may be paid in easy monthly payments. The Hon. Calvin Coolidge wrote: "Webster's New International Dictionary has been the official reference and authority in my office in Washington during my service as Vice President. It is a standard work and most useful to me." Send coupon for the free booklet, "The Magic of Words," and see why it will be most useful to you.

G. & C. MERRIAM COMPANY
Springfield Mass.

The Magic of Words

is working miracles of achievement every day. It enables one man to convince his business associates, another to win a case in court, another to play on the emotions of a great audience. Words rightly used are the *open sesame* to cultured society, to business success, to political power. *You* can use the magic of words in attaining *your* great ambition. You need only develop your mastery of expression by using the language power so fully offered to you in WEBSTER'S NEW INTERNATIONAL DICTIONARY.

Yours Free on Request

"The Magic of Words"

You may have this interesting, illustrated booklet free. You will enjoy its illuminating story and profit by its practical suggestions. It offers also full information about the highest authority of the English speaking world.

This Coupon Brings Your Copy, FREE

G. & C. Merriam Company,
Springfield, Mass.
Please send me, without cost or obligation, the illustrated booklet, "The Magic of Words" and full information on Webster's New International Dictionary and your special *Free Atlas* offer. (*Pop. Sci. 10-24*)

Name _____

Street _____

City and State _____

Money Making Opportunities

PHOTOGRAPHY AND SUPPLIES

HAVE you a camera? Write for free sample of our big magazine, showing how to make better pictures and earn money. American Photography, 117 Camera House, Boston, 17, Massachusetts.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Address your inquiry to:—Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Avenue, New York.

CLEAR, bright prints that will never fade; 3c each for vestpocket size; brownie No. 2 and No. 2A, 4c each, larger sizes, 5c each. 8x10 enlargement 55c from any kodak film. We develop any roll film for 10c; film packs 25c, mailed back same day. Satisfaction guaranteed. Leon Lambert, 670-E South Volutsia, Wichita, Kansas.

DEVELOP and print your own films. Complete formulas, 60c (no stamps). Results guaranteed. Studio "L," Owego, N. Y.

AUTHORS—MANUSCRIPTS

WRITE: for newspapers and magazines. Big pay. Experience unnecessary, details free. Press Reporting Syndicate, 971, St. Louis.

WRITERS—Stories, poems, plays, etc., are wanted for publication. Literary Bureau, 117, Hannibal, Missouri.

I WANT song poems, Casper Nathan, J-1252 Bryn Mawr, Chicago.

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"NATURE'S FINER FORCES"; Vibrations; Lights; Colortones; Electromagnetos; Odicauras; Radio; Coldlights; Inventions; Wonderful Opportunities; Fifty Lessons; Marvelous Cures; Illustrated; 270 pages. $2.00, Deluxe $3.00. Stevens Science Publishers, 242 Powell, San Francisco.

PUBLISH a Magazine of your own. We will tell you how. Very interesting, profitable. Information free. Lutz Printing Co., York, Pa.

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More Money Making Opportunities on pages 6 to 26

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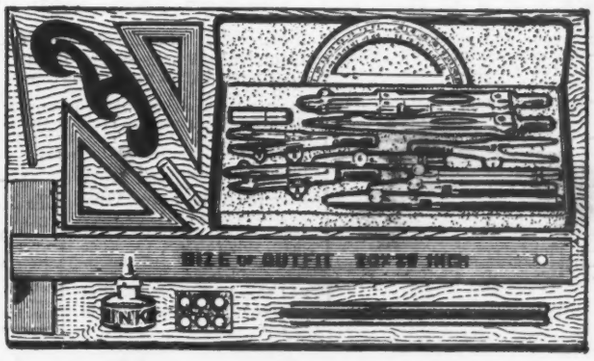
Write and I'll tell you how I make you a first-class, big-money-earning draftsman in a very few months! I do this by a method no other man nor institution can imitate. I give you personal training at home by mail until you are actually placed in a position paying up to $250 and $300 a month. Six thousand draftsmen are wanted every month.



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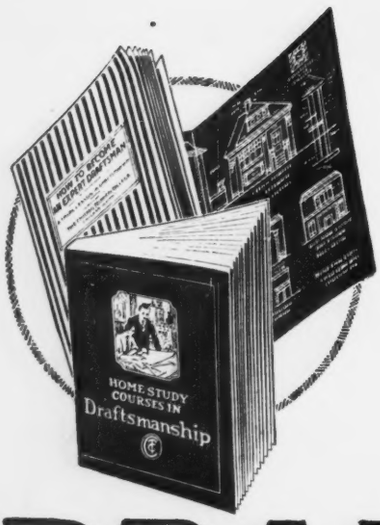

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Get this expert training in Draftsmanship and put yourself in the big pay class. Don't stay in a small job when you can master Drafting in your spare time by the Chicago Tech. Method. Not enough expert Draftsmen to fill the high salaried positions open now. You don't need special, preliminary education to master Drafting. The Chicago Tech. Method makes every step so easily understood that any intelligent man can master the subject.

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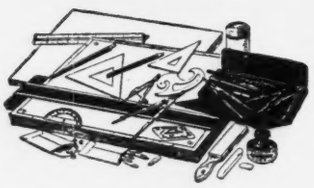

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Send for Catalog "B" and our Free Book "How to Read Blue Prints". See how you can increase your earnings by learning more about the higher branches of your trade—Plan Reading, Estimating, Superintending.

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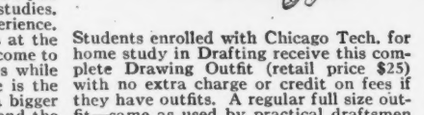

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Money Making Opportunities

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THE World's Largest Dog Kennels offer for sale Oorang Airedale watch dogs, automobile dogs, children's companions, farm dogs, stock drivers, hunters and retrievers. Also Big Game Hounds, Coonhounds, Foxhounds, Rabbit Hounds and thoroughbred Hound and Airedale puppies. Satisfaction and safe delivery guaranteed to any point in the United States. Large illustrated descriptive catalog free. Oorang Kennels—Box 208—La Rue, Ohio.

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GUARANTEED Reliable Formulae, Trade Secrets, Rare, Dependable Manufacturing Processes for all lines, detailed working directions, "inside" commercial information. Don't buy till I've sent you my Valuable Literature, Lists. Satisfaction Guaranteed. Dr. Liscomb Miller, Industrial Chemist, Tampa, Florida.

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BALDNESS Cured. German formula positively grows hair. $3. The Process Co., Denver, Colo.

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OH Boys Make and Sell Automobile Enamel. Makes any old faded car look like new. Apply to car with a piece of cheesecloth, 80c. profit on a dollar bottle. Formula and working plans $1.00. MITCHELL-Ames Co., Effingham, Illinois.

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More Money Making Opportunities on Pages 6 to 26

The Only Way Out of a Pit—UP!

IT was Jack London—penniless and with only a scanty education—who uttered those words—

—"The only way out of a pit is UP!"

That one clear challenge, flashing across his mind with the force of inspiration, gave the impulse to work and study which set him on his way to a brilliantly successful career.

The One Great Test—COURAGE!

It has been said that the great difference between one man and another is in the amount of COURAGE he possesses.

Not PHYSICAL courage, of course, but the courage to turn the searchlight on one's MENTAL equipment, to recognize the training which one lacks, and to do as Jack London did—climb out of the "pit."

Right now, in your own office, there are probably dozens of men who are performing the same old routine tasks they have been performing for years—tasks which literally millions of men could do equally well; yet hardly a man in the lot but thinks he is having a "mighty hard time" and that "luck never seems to break his way."

But how CAN it break his way—when he is obviously not PREPARED?

How futile, for example, to expect an employer in need of an expert accountant to appoint a man—at five or six thousand a year—who knows nothing beyond the keeping of a set of books.

—Or to expect the head of the firm to entrust his transportation problems to a man who has got all his knowledge about traffic management from the shipping room and the loading platform!

—Or to expect ANY reputable business house to choose, say, as district manager a man who has no conception whatever of salesmanship—to advance to the superintendent's desk a foreman who knows nothing about industrial management efficiency—to entrust a direct-by-mail campaign to a routine correspondent—or to appoint a "one-department man" as general manager . .

It may be RESTFUL to stand at the bottom of the pit and to gaze at the stars—but the SHREWD thing to do is to seize the rope of SPECIALIZED TRAINING—and to pull oneself OUT!

The Kind of Experience That COUNTS

—And EASIER, too, by far, than one might suppose—this climbing to a higher place by the aid of specialized training.

For within the last two decades a method of business training has been evolved which marks an advance beyond the earlier correspondence-school idea as outstanding as the advance of radio beyond the original Marconi "wireless."

Under this modern method—distinctive with LaSalle Extension University—every portion of the work is directed toward the rapid imparting of ORGANIZED EXPERIENCE.

Step by step, the member is shown the PRINCIPLES which govern the various business situations he must face in that bigger place—and step by step he fixes those principles firmly in his mind through the solving of ACTUAL BUSINESS PROBLEMS.

A dozen times a man might READ how to do a thing—how to swim, for example—and STILL be unable to do it!

But let him grasp the PRINCIPLES that govern an undertaking—and let him put them into successful PRACTICE—and he has acquired the greatest asset a business man can possess—thoroughly practical EXPERIENCE.

A Club That Everyone Likes to Join

Hundreds—yes, thousands of letters in the files of LaSalle Extension University bear out the scientific soundness of the LaSalle Problem Method.

The members of LaSalle, for example, have a club they call the "100% Club," to which no man is eligible until he has increased his salary at least one hundred per cent. Not a month goes by but what scores of names are added to its rolls.

Indeed, if we liked, we could fill this page—in close-set newsprint type—with the names of just a small proportion of the men who have actually DOUBLED and TRIPLED their incomes through the Problem Method.

These men, you will say, are men of unusual determination and persistence—

Absolutely true.

—But also true that no one KNOWS what he can do until he TRIES.

And ANY man in earnest to advance will find encouragement in the fact that the AVERAGE salary-increase reported by LaSalle-trained men is EIGHTY-NINE PER CENT.

Ask Yourself if You Can Qualify—Then ACT!

There is a certain class of men who seem content in a low-pay job.

There is still another class in whom the phrase "I can't" is so deep-rooted that they seem afraid to grasp the fairest opportunity.

Neither of these types are sought by LaSalle—nor would they profit greatly by its training.

There are countless other men, however, who appreciate what specialized training MEANS—who realize the tremendous HELP it offers—and who are not afraid to take their chance against the entire field of competition.

To men of this latter sort LaSalle Extension University has much to offer—both for mental growth and for increased earning power.

If you are in earnest when you say that you wish to get ahead, you will take your pen or pencil NOW—and check the training that appeals to you.

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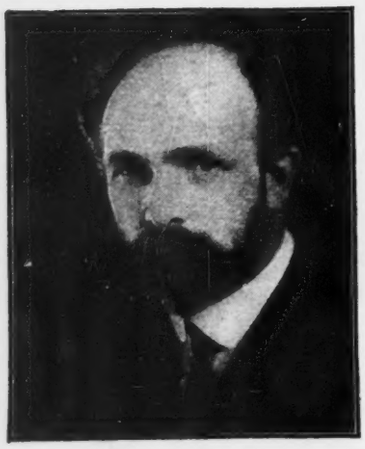

How to speak and write Masterly English

Thousands of people make little mistakes in their everyday English and don't know it. As a result of thousands of tests, Sherwin Cody found that the average person is only 61% efficient in the vital points of English. In a five-minute conversation, or in an average one-page letter, from five to fifty errors will appear. It is surprising how many experienced stenographers fail in spelling such common words as "business," "abbreviate," etc. It is astonishing how many business men say "between you and I" instead of "between you and me," and use "who" for "whom", and mispronounce the simplest words. Few persons know whether to use one or two "c's" or "m's" or "r's," whether to spell words with "ie" or "ei," and when to use commas in order to make their meaning absolutely clear.

A REMARKABLE INVENTION

Mr. Cody has specialized in English for the past twenty years. But instead of going along in the old way he has applied scientific principles to teaching the correct use of our language. He made tens of thousands of tests of his various devices before inventing his present method. In all his tests he found that the trouble with old methods is that points learned do not stick in the mind. In school you were asked to remember rules and if you forgot the rules you never could tell what was right and what was wrong. For many years Mr. Cody has studied the problem of creating instinctive habits of using good English. And as a result of his experience he evolved his wonderful new

SELF-CORRECTING METHOD

A patent was granted Mr. Cody on his unique device, and now he places it at your disposal. This invention is simple, fascinating, time-saving, and incomparably efficient. You do the lesson given on any page, then you see exactly how Mr. Cody himself would correct it. You mark your errors and check them in the first blank column. Next week you try that page again, on the second unmarked sheet, correct your errors, and check them in the second column. You see at a glance what you have learned and what you have failed to remember, until you have reached the 100% point in spelling, punctuation, grammar, and expression.

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A remarkable advantage of Mr. Cody's course is the speed with which these habit-forming practice drills can be carried out. You can write the answers to fifty questions in 15 minutes and correct your work in five minutes more. You waste no time in going over the things you already know. Your efforts are automatically concentrated on the *mistakes* you are in the habit of making, and, through constantly being shown the *right* way you soon acquire the *correct* habit in place of the *incorrect* habit. There are no rules to remember. There is no tedious copying. There is no heart-breaking drudgery.

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Money Making Opportunities

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"INVENTOR'S ADVISER" the valuable Patent book with 139 mechanical movements and illustrations, sent free upon request.—M. S. Labiner, Patent Attorney, 3 Park Row, New York.

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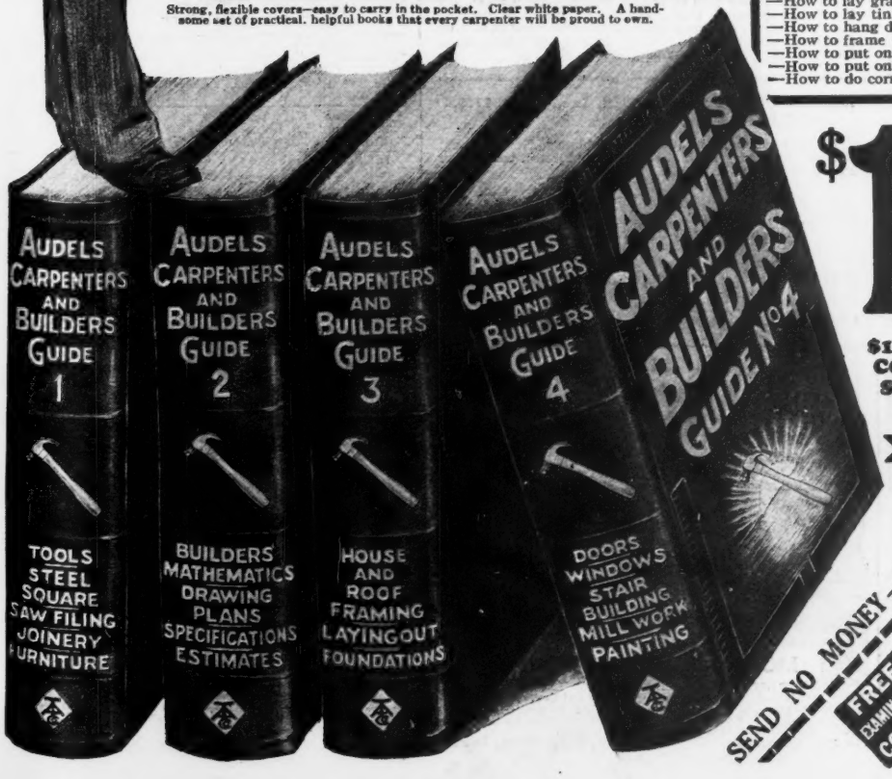
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By ALOIS MERKE

Founder of Famous Merke Institute, Fifth Avenue, New York

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Yet now, through a series of ingenious inventions, I have made it possible for every one to avail themselves of my method—right in their own homes, and at a cost of only a few cents a day!

My Unusual Guarantee!

I know you are skeptical. I know that you have tried perhaps dozens of different remedies and treatments without results. I know that you have wasted time and money on treatments which by their very nature could NEVER restore your hair. All right. Perhaps my treatment cannot help you either. I don't know. But I do know that it has banished falling hair and dandruff for hundreds of others—often with the first few treatments. I do know that it has already given a new growth of hair to people who long ago had despaired of regaining their hair. And I am so downright positive that it will do the same for you that I am entirely willing to let you try it at my risk—and if it fails to restore your hair, then I'll instantly—and gladly—mail you a check, refunding every cent you have paid me. In other words, I absolutely GUARANTEE to grow new hair on your head—and if I fail, then the test is free.

What Users Say:

Letters like the following are received almost every day by the Merke Institute.

"In the short time I have used your treatment I have gained remarkable results. Dandruff has disappeared entirely. My scalp is now all full of fine new hair. Would not part with my treatment for 10 times its cost." A. W. B.

"The top of my head is now almost covered with new hair about one-half inch long. I have been trying five years but could never find anything to make my hair grow until your treatment." T. C.

Entirely New Method

What is my method? It is entirely new. It is entirely different from anything you ever heard of. No massaging—no singeing—no "mange" cures—no unnecessary fuss or bother of any kind. Yet results are usually noticeable even after the very first few treatments.

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I have disproved this. For I have found in many cases which have come under my observation that the hair roots were NOT dead, but merely dormant! Through undernourishment, dandruff and other causes, these starving, shrunken roots had literally gone into a state of "suspended animation." Yet no matter how thin hair may be, it is now possible in a very great many cases to awaken these dormant roots and stimulate an entirely new growth of healthy hair! I KNOW this to be true—because I do it every day.

Ordinary measures failed to grow hair because they did not penetrate to these dormant roots. To make a tree grow, you would not think of rubbing "growing fluid" on the bark. Instead you would get right to the roots. And so it is with the hair.

In all the world there is only one method I know about of penetrating direct to the roots and stimulating them into new activity. And the principle of this method is embodied in the treatment that I now offer you on my positive guarantee of satisfactory results, or the trial costs you nothing. The treatment can be used in any home in which there is electricity.

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Remember—I do not ask you to risk "one penny" in trying this treatment. I am perfectly willing to let you try it on my absolute GUARANTEE—and if after 30 days you are not more than delighted with the growth of hair produced, then I'll gladly return every cent you have paid me. I don't want your money unless I grow hair on your head.

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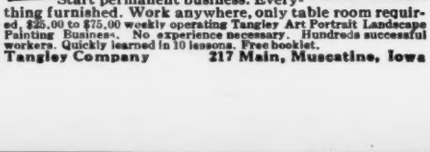

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ARE you old at forty? See our advertisement on page 148 of this issue. The Electro Thermal Company, 4038 Main Street, Steubenville, Ohio.

More Money Making Opportunities on pages 6 to 26

How to Invent— What to Invent

and What to Do About Protecting and Selling An Invention

ALTHOUGH the fact has been universally recognized that Invention is governed by a few simple, easily acquired, fundamental principles, no one ever thought of putting these principles in black and white so that everybody interested in invention could read them. In spite of the fact that Thomas A. Edison made his famous statement that invention should be taught as a science, thousands of people continued to work blindly, doggedly, haphazardly to perfect their ideas.

But now anyone can learn how to invent. Fifteen famous inventors have at last given to the world the laws and principles of Inventive Science. They have shown every ambitious man and woman how to invent. They are teaching Invention exactly as other people are teaching law, medicine, bookkeeping. Instead of spending years groping blindly, instead of wasting your time in useless, heartbreaking drudgery, you learn how to complete your ideas quickly *and what to do about them* when they are completed. You learn how to think so you are sure to succeed.

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Raymond F. Yates, who with fourteen other famous inventors now makes it easy for you to learn how to invent in your spare time at home.

Everybody Invents

For a long time it was commonly believed that every invention was a matter of pure luck—the result of some happy inspiration that suddenly flashed through a man's brain, and which made him fabulously rich without the slightest effort or thought. But you can prove for yourself that this is not so. You can prove for yourself that invention is the result of thinking and action along definitely exact, scientific lines.

Suppose when you went home tonight you found a window rattling. Through your mind would flash, almost instinctively, a regular order of thoughts which characterize the conception and completion of every invention the world has ever known. First, you would recognize a problem to be solved—the rattling of the window. Then you would think of several principles of science or mechanics which would solve your problem. You might think of the scientific fact that if you poured water on the frame the would would swell and tighten the window. You might think of using a nail. But what you most probably would do would be to use the oldest mechanical principle known to man, the wedge.

What Invention is

Brought down to its simplest terms, that is exactly the way every invention has been made—combining two ideas; a problem which must be solved and a fact of mechanics or science which solves the problem. So, although you may never have thought of it in just this way, every time you solve a problem in your daily life—at home, traveling, or in business — you are an inventor; you use the principles of thought and action which govern the Science of Invention!

You can see, therefore, how easy it is for you to develop your natural instinct to "fix things." The same processes of thought that almost instinctively told you to fix a rattling window with a wedge can be so well developed that you can learn to invent other things almost as easily and quickly. You know, too, that every invention is made only by thinking inventively. And every inventor is agreed that the principles of Inventive Science are so simple, so easy to learn that anyone, regardless of training or education, can develop himself to become a successful inventor!

With every new advance, with every new discovery that the world experiences, more problems are coming up—and more inventions are needed to solve these problems. Now, as never before, are new inventions wanted, and the world will pay a fortune to the man or woman who gives it just one of the inventions it needs.

Even little ideas can bring you a fortune. Eberhard, who invented the rubber on the end of a pencil, has been paid hundreds of thousands of dollars for his simple idea. The man who invented the metal tip for shoelaces, the man who conceived the idea of the "humped" hairpin, the man who developed the metal tape measure, all have achieved success and wealth as great or greater than the inventors of large machinery.

Learn How to Invent at Home

If you would like to develop your natural inventive ability along *money-making* lines, instead of trifling with ideas — if you would like to DO something about your ideas instead of letting someone else patent and market them ahead of you, let this great Course in Inventive Science help you. Get the advice and help of the fifteen famous inventors who tell you the secrets of invention which you MUST know to be successful.

This is the first course in practical invention that has ever been devised. In simple, easy-to-understand language you are told how successful inventors work; you learn how to think along inventive lines, you learn the short-cuts to successful invention; you learn how to use the secrets of invention that convert a simple little idea into money.

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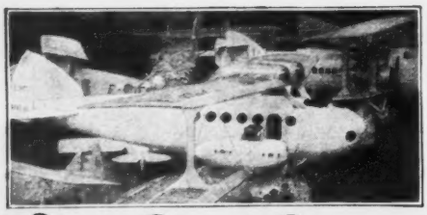

Aviation Brings Quick Success

TO young men of daring no other field of work offers such a fascination, such high pay, nor such opportunities for quick success as the field of Aviation. As yet, aviation is practically in its infancy. But now is the time to get in.

Amazing Opportunities in Airplane Industries

In the automobile industry and in the moving picture business hundreds of men got rich by getting in at the start. They made their success before others woke up. Today, these lines offer no greater opportunities than a hundred and one others. BUT AVIATION IS NEW. Get in while the opportunities are big. All over the country there will be a clamor for trained men. It will not be a question of pay but of getting capable men.

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The study of aviation is almost as fascinating as the actual work. Every lesson is full of interest. That is why it is easy to learn aviation. You do not have to make yourself study—it is like reading an interesting book that tells you things you have always wanted to know. Only one hour each evening will give you the basic training in a surprisingly short time.

One student, S. F. McNaughton, Chicago, says: "Your lessons are like a romance, and what is more, after one reading, the student gets a thorough understanding. One never tires of reading them." James Powers, Pa., another student, says, "I am indeed surprised that such a valuable course can be had from such practical men for so little cost."

Fascinating —Daring— Big Paying

Prepare Now for One of These Positions

Aeronautical Instructor $60 to $150 per week
Aeronautical Engineer $100 to $300 per week
Aeronautical Contractor Enormous profits
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Aeroplane Mechanician $40 to $60 per week
Aeroplane Inspector $50 to $75 per week
Aeroplane Salesman $5000 per year and up
Aeroplane Assembler $40 to $65 per week
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Men who have had actual experience give you personal attention. They select the lessons, lectures, blueprints and bulletins. They tell you things that are essential in everyday practice. Each lesson is easy to read and understand.

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Send coupon below for New Book, just out, "Opportunities in the Airplane Industry." It is interesting and instructive. It will show you many things you never knew before about aviation. We have but a limited supply of these books—send the coupon before they are all gone.

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MANUFACTURE Millerite! You've read about this New Ethyl-Super-Fuel Ingredient for Gasolene. Increases power, Mileage—Saves Gas—Knocks Carbon—Easily made. Your Profit Immense! Stamp brings Valuable Descriptive Formula, Literature of this and Mendit, Fabric Mending Cement, Lightning Electrolyte; Rubber Balloons; Amazon Self-vulcanizing Rubber Repair; Pro-Tex-U, Only Guaranteed Fire Extinguisher; Flynox, few drops kills roomful flies; Marcel, Permanent Hair Curling Fluid; Denta-perl Tooth Whitener. Latest Pure Food Products; Flavors; Beverages; Toilet, Medical; Household; Automobile; Office; Specialties; all lines. You'll be glad you received these lists. Miller, Industrial Chemist, Tampa, Florida.

THE clothing business is the second largest business in the country. Men have made fortunes in it. So can you if you go into it right. We'll put you into it right without one penny of expense to you and supply everything you need to go into the business and clear $100 to $200 right from the start. This is a wonderful opportunity for the right man. If interested, write at once. Address Dept. 278, Goodwear Chicago, Inc., West Adams Street, at Peoria, Chicago.

AGENTS: Send for sworn proof $5 to $15 daily—Introducing Latest Style Guaranteed Hosiery—57 styles—37 colors—Neither experience nor capital needed—Just show samples—take orders—YOUR PAY DAILY—We deliver and collect—All transportation charges paid—Monthly bonus besides—Twelve hour service—Complete outfit furnished—All colors—grades including silks—Early Fall and Winter samples now ready—Macochee Textile Company, Room 15210, Cincinnati, Ohio.

AGENTS—I want hustling young men to take charge of my business in their home neighborhoods. $1.25 an hour for spare time. Permanent positions. Dignified work. No experience or capital required. Costs nothing to start—I furnish everything. Answer quick. Harley Co., 2020-L Harley Bldg., Dayton, Ohio.

AGENTS—Steady income. Large manufacturer of handkerchiefs and dress goods, etc., wishes representative in each locality. Factory to consumer. Big profits, honest goods. Credit given. Send for particulars. Freeport Mfg. Co., 24 Main St., Brookiyn, N. Y.

DISTRIBUTORS, Envelope Sealer. Seals 3500 envelopes hour. Amazing invention!! No competition. Retails $4.00 only. $20,000 yearly. Red-E Co., Dept. A. F., 100 Boylston, Boston, Mass.

STATE Distributor. Wonderful newly invented Pricing System retails $4.90. Tremendous demand!! Big repeat business. $20,000.00 yearly. Millen Mfg. Co., Dept. A. T. Colonial Bldg., Boston, Mass.

$2.00 AN Hour for pleasant introductory work among local families. Experience unnecessary; permanent position; pay starts immediately. Write American Products Company, 1988 American Bldg., Cincinnati, O

YOU can save $7 on each Auto Tire. Write for particulars. Agents wanted. American Accessories Co., Dept. 1079, Cincinnati, Ohio.

AGENTS—Make a dollar an hour. Sell Mendets, a patent patch for instantly mending leaks in all utensils. Sample package free. Collette Mfg. Co., Dept. 467, Amsterdam, N. Y.

NEW Jersey manufacturer wants Salesmen, Agents and Distributors for Tri-Me Spark Plug Combination Tool. For particulars—E. U. Engineering Co., Orange, N. J.

AGENTS wanted. $60-$200 a week. Genuine Gold Letters for store windows. Easily applied. Free Samples. Liberal offer to general agents. Metallic Letter Co., 434A, North Clark, Chicago.

BIG Profits. Rubber Specialties. Fifty fast sellers. Everybody needs and buys. $50 weekly easily made. B. & G. Rubber Co., Dept. 643, Pittsburgh, Pa.

SALESMAN: If you think in terms of $6000 the first year, write me personally. Strong line for retail stores. Nationally advertised. Established concern has unusual opportunity. Liberal weekly advance to producer. Geo. R. Williams, Mgr., 1922 Euclid Avenue, Cleveland, Ohio., Dept. 201.

SALESMEN—Distributors. Right men can make steady income and establish permanent business in article that is proved success. Nationally advertised. Thousands in use. Write or wire—good territory going fast. C.F.S.CO., 14 N. 10th St., Richmond, Ind.

TAILORING Salesmen, $150.00 weekly. Liberal Bonus and large commission selling $45.00 All-Wool Suits, $32.50. Union made to order by oldest tailors on earth. Satisfaction Guaranteed. Experience unnecessary. Write today for free outfit, exclusive territory. Wilson Tailoring Co., 936 W. Jackson, Chicago.

BRUSH Sales Managers. Both you and your salesmen can make unusual profits selling our standard quality wire-twisted brushes and mops. Write Cleveland Brush & Mop Co., Specialty Dept. B, 8109 Townsend Ave., Cleveland, Ohio.

SALESMAN earn $15 to $20 daily selling Manchester Twill garments made to measure, $12.50. Write for particulars. Chicago Utility Garment Corp., 1432 Altgeld St.

BIG money selling gold initials. Quick Sales. Every car owner buys. You charge $1.50—Make $1.44 every sale. Your profit $20 Daily. No license. No experience. "Samples free." Nulife (P) Monogram Company, Hartford, Conn.

MAKE $17 day—Finest extracts, food products, toilet preparations, household necessities. Credit: sample case free. Write for amazing offer. Perkins Products, B-26, Hastings, Nebr.

AGENTS Wanted—Something New—Fire fighter sells easily. Makes a spectacular demonstration; car owners, homes, factories, stores, practically buy on sight. Our men make $10.00 to $50.00 a day. If you wish to establish a business of your own with unlimited possibilities for making big money, write us today. Fyr-Fyter Co., 282 Fyr-Fyter Bldg., Dayton, Ohio.

MAKE extra money. Xmas postal, folder, tag combination packs. 10th season. Sell 25c. Sample 15c. Big profits. Ufert, 133 West 15th, New York.

AGENTS—Make $15 and more each day selling New All-Weather Coat at $4.98. Full or spare time. Improved Mfg. Co., Dept. 910C, Ashland, Ohio.

AGENTS Coining Money. $1.40 profit on every $1.50 sale. Monograming Automobiles. Free samples. Worcester Monogram Co., Worcester, Mass.

BIG money and fast sales. Every owner buys gold initials for his auto. You charge $1.50, make $1.44. 10 orders daily easy. Information and samples free. World Monogram Co., Dept. 25, Newark, N. J.

More Money Making Opportunities on pages 6 to 26

Follow this Man!

Secret Service Operator 38 Is on the Job!

FOLLOW him through all the excitement of his chase of the counterfeit gang. See how a crafty operator works. Telltale finger prints on the lamp stand in the murdered girl's room! The detective's cigarette case is handled by the unsuspecting gangster, and a great mystery is solved. Better than fiction. It's true, every word of it. No obligation. Just send the coupon.

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The Confidential Reports No. 38 Made to His Chief

And the best part of it all is this. It may open your eyes to the great future for YOU as a highly paid Finger Print Expert. More men are needed right now. This school has taken men just like you and trained them for high official positions. This is the kind of work you would like. Days full of excitement. Big salaries. Rewards.

Can You Meet This Test?

Can you read and write? Are you ambitious? Would you give 30 minutes a day of your spare time preparing yourself for this profession? Would you like a life of excitement, thrilling adventures and high pay? Answer yes and I'll show you how to attain all this.

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The Associated Electrical Engineers Famous "Experience Method" Brings a Big New Day in Your Electrical Training

You can now become a skilled Electrical Expert and qualify for jobs paying $2,500, $5,000 a year and up, in but a fraction of the time previously necessary

The Associated Electrical Engineers, under the direction of Chief Engineer W. N. Littlewood, have developed a marvellous **New Method** of Electrical Training that you can quickly and easily master right in your own home, in your spare time, that will open wide to you the tremendous opportunities that Electricity offers.

This new training in Electricity is the greatest and most revolutionary advance ever made in home study training. There is nothing like it anywhere. The quick success of men trained under the famous A. E. E. Experience Method is amazing.

James DuBall, Fort Niagara, Ont., writes: "How you can put so much information in such a few lines is beyond me." Julio Fuentes, Cleveland, Ohio, just beginning his training writes: "I am already doing a lot of wiring and repairing and making big money." J. A. Hoekzema, Grand Rapids, Mich., not a third through his training, writes: "I have started my own business and am doing fine." Hundreds of such letters are pouring in from A. E. E. trained men, who began making money almost from the start.

The reason for the remarkable and quick success of the A. E. E. Experience Method of Electrical Training is because it is not the old fashioned "schooling"—A. E. E. trained men are **experienced men**—A. E. E. training in Electricity is **electrical experience.**

Let us send you our big new 48-page Book, "Electricity and its Opportunities for **you**" which tells all about this marvellous new advance in Electrical training. It is too big and too vital a story to try to tell on this page. The book is absolutely free.

Electricity is the biggest thing in our lives today. No industry has ever grown so rapidly—no other industry presents the wonderful opportunities—not opportunities five or ten years hence, but **right now**—for big money, big jobs, real independence. $3,000, $5,000, $7,500, $10,000 a year and up is being paid to thousands of men in Electricity right now, and the call is for more and more men to keep pace with this tremendous growth.

Herbert Hoover says, "that **forty billions of dollars** will be invested in Electrical Development in the next few years. How many **big, new** Electrical jobs and opportunities will this tremendous investment create?

Electricy needs trained men—thousands of them. **Your** opportunity is ready for you just as soon as you are ready for it. Electricity is growing faster than men can be trained. Do not waste any more time in the old crowded, low-pay vocations that have no future when the great Electrical Industry beckons you.

Do not waste time and effort learning Electricity by old, obsolete "school" methods. Life is too short and Electricity needs you **now.**

Write now—today—for our great new book on Electricity and let us tell you of the **big new day in Electrical Training**—how the A. E. E. Experience Method has taken all the old difficulties and obstacles out of Electricity, and how it will **quickly, easily and surely** put you into the big-money, big-opportunity, fastest growing industry on earth—electricity.

But that is only half the wonderful story of the Associated Electrical Engineers—the world's greatest and fastest growing Electrical training organization. You must know of the many other remarkable and **exclusive** benefits and advantages it offers to its members.

Let us tell you of our remarkable **Free** Electrical Business Training Course, and how we not only develop you quickly into a top-notch Electrical Expert, but also train you and help you to cash in on your ability—another great forward step due to the enterprise of the A. E. E.

Let us tell you how **over 200 highly trained practical Electrical Engineers, holding big, important positions, have certified that A. E. E. Training is Right**—no other home training in Electricity has ever received such an acid test.

All these great features, and many others—how you gain experience working with **real** electrical equipment on practical jobs in the A. E. E., for example, are fully described in our great **Free book**—yours for the asking without any **obligation** whatever.

If you are really **ambitious**; if you want to get into the uncrowded, biggest pay and fastest growing business on earth, then by all means send for this book. Investigate all you want; find out what others have to offer; but whatever you do, do not fail to investigate the many **new, exclusive** advantages that will be yours as a member of the great Associated Electrical Engineers—the World's Greatest Electrical Training Organization. This much you owe to yourself. It will cost you but a stamp to investigate and it can well mean the big turning point in your whole life, as it has for many others.

You can master the A. E. E. Experience Method—you have education enough—we guarantee you full satisfaction on every point—but send for the big free book—that tells the whole remarkable and inspiring story.

Here's the coupon that will bring you face to face with **Big Opportunity.** Use it now while it is before you, and resolve to get into the great Electrical Industry where you can give orders instead of taking them.

W. N. LITTLEWOOD, Chief Engineer, Associated Electrical Engineers of America, Dept. 204, 537 S. Dearborn Street, Chicago, Ill.

I want to know all about the A. E. E. Experience Method of Electrical Training and all the other new and exclusive features of the A. E. E. It is understood that your 48 page book is absolutely free and that I incur no obligation whatever is asking for it.

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No Routine Work for—CARTOONISTS

$100.00 a Week

Easy Hours!—and Your Own Boss

WHY work on a job that pays small money and has all sorts of routine drudgery attached to it when thru a remarkable easy, home-study method you can quickly learn to make cartoons that *sell?*

Even if you never had a drawing pencil in your hand, you can learn to draw this quick, simple way and enjoy the fascinating life of a successful cartoonist—easy hours—freedom from routine—your own boss—and make as much as $100 a week or more. And you learn right at home in your spare moments. You start at the very beginning with the simplest fundamentals of cartoon-making. No wasting of time on unnecessary details. Step by step you progress easily until soon you know how to make saleable cartoons of every description. Many of our students have sold enough work while studying to pay for the course many times over.

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Never before has there been such a tremendous call for original cartoons—newspapers and magazines can't get enough of them to supply the public demand. And every day finds new uses for cartoons—in advertising, in the movies and in countless other ways. Now is the time to study cartooning—right now there is a wonderful opportunity for *you* in this uncrowded field.

Send for Free Book

Mail coupon today for our handsomely illustrated book, which will be sent you absolutely free of charge. It tells how you can become a cartoonist in a few minutes daily spare time and at a cost of only a few cents a day. Explains about this amazing method in detail. Tells of our students and their wonderful progress. Also the real big-money opportunities that we can qualify you for. Send for it today!

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Please send me, without obligation, your Free Booklet on Cartooning and full details of your home-study method of teaching Cartooning. **(Print name plainly)**

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This coupon, filled out as directed, entitles the sender to (1) free specimen examination questions; (2) a free copy of our book, "Government Positions and How to Get Them"; (3) free list of positions now obtainable.

COUPON

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Use it before you lose it. Write plainly.

Money Making Opportunities

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ONLY one sale a day means $200 per month! Five sales $1,000 per month. Marvelous new adding machine. Retails $15.00. Work equals $350 machine. Adds, subtracts, multiplies, divides automatically. Speedy, accurate, durable, handsome. Five year guarantee. Offices, stores, factories, garages buy one to dozen. A fortune for live agents. Write quick for protected territory and free trial offer. Lightning Calculator Co., Dept. P. Grand Rapids, Michigan.

SALESMEN, can make $5.00 a day selling our calendars, pencils, signs, advertising noveities, yardsticks, whistles, etc. Liberal terms. Sells entire year. Fine side line. Local and traveling agencies. Model Calendar Co., Dept. 309, South Bend, Indiana.

INSTANT Weld—Repairs largest punctures without cement or heat. Lenn's profit one day $56. Write quick. Free sample. Territory going fast. Tourist's Pride Mfg. Co., Desk R. Minneapolis, Minnesota.

STAMPING names on emblem key checks. Sample 20c. Key check outfits, steel dies, key cases, etc. Service Sales Corporation, Shelby, Ohio.

AGENTS—Clever Invention! Inkspoon makes every pen a fountain pen. Fast office seller, big profit, demand increasing everywhere. Exclusive territory offered. Sample free. H. Marui Company, Tribune Building, New York.

AGENTS—100% profits. Fast-selling novelty for Lodge members. Emblematic Belt Co., Dept. D., Ashland, Ohio.

AGENTS—Best seller; Jem Rubber Repair for tires and tubes; supersedes vulcanization at a saving of over 800 per cent; put it on cold, it vulcanizes itself in two minutes, and is guaranteed to last the life of the tire or tube; sells to every auto owner and accessory dealer. For particulars how to make big money and free sample, address Amazon Rubber Co., 504 Amazon Building, Philadelphia, Pennsylvania.

EVERY house a sale; Fast sellers; Particulars. Helmers Company, Desk No. 12, Hoboken, N. J.

31 BILLION, 650 million marks, real German currency for only $1.00. Wholesale prices with order only. Atlantic Co., 1209 Beach Ave., Bronx, New York.

MAKE $25 to $50 week representing Clows Famous Philadelphia Hosiery, direct from mill—for men, women, children. Every pair guaranteed. Prices that win. Free book "How to Start" tells the story. George Clows Company, Desk 24, Philadelphia, Pennsylvania.

SELL beautiful $7.00 red and black over-sized hand made Fountain Pens for $3.50. Cost you $1.75. With bonus $1.55. Post card brings full details, or C. O. D. sample, at wholesale price. Johnson Pen Co., 117 South First St., Rockford, Ill. Dept. C.

SALESMEN wanted to sell our line of labels as side line. Commission. Patrick Label Co., 49F South Ave., Rochester, N. Y.

DUSTLESS Sponge Cloth, New Invention. (1) Rub—Dusts, Cleans and Polishes Automobiles, Furniture, Pianos, Retails 50c.—Costs 16c. Sample Free. Nulife Sponge, Hartford, Conn.

WE start you without a dollar. Soaps, extracts, perfumes, toilet goods. Experience unnecessary. Carnation Co., Dept. 21, St. Louis.

SALESMEN sell sales and order books, auto, reg. rolls and bill ladings. Large demand. Liberal commission. Wirth Sales Book Co., Dept. PS, Chicago.

EARN $10 daily silvering mirrors, plating and refinishing metal ware, headlights, chandeliers, bedsteads. Outfits furnished. F. Decie Laboratories, 1133 Broadway, New York.

MAKE $100 weekly in spare time. Sell what the public wants—long distance radio receiving sets. Two sales weekly pays $100 profit. No big investment, no canvassing. Sharpe of Colorado made $955 in one month. Representatives wanted at once. This plan is sweeping the country—write today before your county is gone. Ozarka, 803 Washington Blvd., Chicago.

PATENTED Cigar Lighters with Glass Advertising Front. Also Electric Cigar Moisteners. Wonderful Sellers. No Competition. Big Steady Profits. Proof, Cuts, Sales Plan Free. Drake Mfg. Co., Dept. P., Milwaukee, Wis.

BIG money and fast sales. Every owner buys gold initials for his auto. You charge $1.50; make $1.35. Ten orders daily easy. Write for particulars and free samples. American Monogram Co., Dept. 47, East Orange, New Jersey.

DISTRICT managers wanted appoint local agents for us in your locality. No canvassing or delivering. $100.00 weekly easily made. Commissions advanced. Bob Russell, H 2309 Arcade, Chicago, Ill.

WANTED—Representatives in every factory in the United States. Popular Science Monthly, 250 Fourth Ave., New York.

MARVELOUS Radio Gas Lighter—lights instantly, sells instantly—easily demonstrated, good for 10,000 lights, retails 25c, cost $10.00 gross, $26 profit. Send $1.00 for sample dozen with self selling plans. L. Masterlite Co., 110 East 23rd, New York.

AGENTS—sell our winter line of men's sheepskin coats direct to wearers. Big profits. No experience necessary. Write to-day for full particulars. Specialty Sportwear Co., Dept. H-205, Court St., Brooklyn, New York.

SUCCEED With Your Own Products—Formulas, Processes, Different, Dependable, Profitable. Catalog Free. C. Thaxly Co., Washington, D. C.

$5,000 TO $10,000 yearly introducing new patented article. Wonderful plan. Exclusive territory. Unusual opportunity. Specialty Mfg. Co., Dept. 15-B, 333 State St., Detroit, Mich.

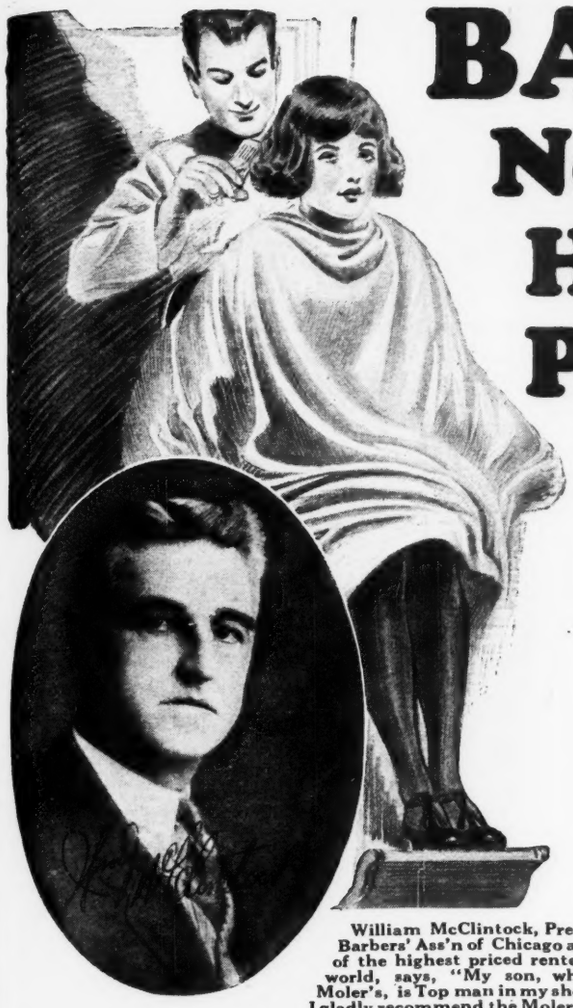
SALESMEN—Earn $50.00 weekly selling custom-made shirts at ready-made shirt prices. 100 latest patterns; price $2.95 up. Shirts individually cut. Unconditional guarantee. Custom Bilt Shirt Company, 538 Broadway, N. Y.

BIG money and fast sales. Every owner buys gold initials for his auto. You charge $1.50, make $1.44. 10 orders daily easy. Information and samples free. World Monogram Co., Dept. 25, Newark, N. J.

SELL union label all-wool made-to-measure suits direct to wearer for $24.50. Scott System, Wholesale Tailors, 99 Bedford Street, Boston, Mass.

EVERYBODY uses extracts. Sell Duo Double strength Extracts. Complete line household necessities. Big repeaters. Write today. Duo Co., Dept. E68, Attica, N. Y.

More Money Making Opportunities on pages 6 to 26



BARBERING Now One of the Highest Paid Professions!

$90 to $150 EVERY WEEK

New Scientific Method Taught Near Your Home Enables You to Cash in On this Amazing Field That Has Been More Than Doubled by Demands of Women

William McClintock, President Master Barbers' Ass'n of Chicago and proprietor of the highest priced rented shop in the world, says, "My son, who learned at Moler's, is Top man in my shop every week. I gladly recommend the Moler System as the proper place for men to become successful barbers."—WM. McCLINTOCK.

I Will Train You in a Few Weeks—Set Up Your Shop in a New Easy Way

IN what other profession can you start earning $50 to $75 a week right from the start? Barbering always has paid well. But now, with the added women's trade it has become one of the highest paid professions—right on an equal footing with law, medicine and other lines that require years of college training. And you can now equip yourself for this dignified, clean, pleasant work in a few short weeks. You can have advantages over the ordinary barber. For under the famous Moler system you are taught new scientific methods that please men and women and never fail to attract extra business. You are made a specialist in your line—and you get a specialist's pay.

Experts Train You Right

There is a Moler school near your home—thirty in all throughout the United States and Canada. Here expert instructors, recognized by the profession as the most expert in the world, teach you the little secrets that will make you the most sought after barber in your locality—and the best paid. In a few short weeks you become far better trained than the ordinary barber who must spend two full years as an apprentice.

Earn While You Learn

And under the Moler system it is possible for you to earn money while you are learning. Thousands of young men acknowledge a debt of gratitude for the help we have given them—help that enabled them to quickly step from the rut of low pay into a hundred dollar a week profession.

Your Shop Equipped On Easy Terms

We have even worked out a plan whereby you can, if you wish, own your own shop, on easy terms. You can own one of the authorized Moler shops—part of a national institution. One of our graduates writes, "My shop has doubled its receipts since becoming one of the Moler chain shops." Our national advertising gives you a tremendous advantage. $1,000 a month is not unusual for Moler shop owners.

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Learn now how you can quickly become a Moler graduate—an expert in bobbing and marcelling, mechanical massage, electric hair cutting, scientific treatments and all barbering for men and women—and take this short cut to big pay. Other Moler graduates tell of earning $100 to $150 a week. Why not you? The best shops know that Moler graduates mean extra business for them. A Moler diploma takes you anywhere.

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IF you like to draw—if you are ambitious to become a highly-paid commercial artist, you are doubtless eager to obtain instruction of proven merit, and profit by the hard-won experience of leading artists.

Think of being able to sit down for an hour with Charles E. Chambers, a leading successful magazine and story illustrator, and learn how he does his work.

Or to be told by Franklin Booth—whose marvelous pen and ink drawings have won for him the title "The Painter with the Pen"—the obstacles he had to overcome and the secret of his wonderful technique.

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America's Foremost Course in Commercial Art

The Federal Course covers every branch of commercial art in a thorough, practical and modern manner. Every step is clearly explained, and you as a student receive an *individual personal criticism* by a successful commercial artist on every lesson—a point not to be overlooked.

Hundreds of Federal students and graduates are making good in a big way. Do not think you have to be a genius—many who are now earning $50, $75, and $100 a week, at first could probably draw no better than you can. The Federal Course does not work miracles—no course can—but develops the ability of an earnest student rapidly and on a sound basis. It brings you to the earning point in a fraction of the time otherwise required. Why not investigate?

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Federal School *of* COMMERCIAL DESIGNING

1355 Federal Schools Bldg.
Minneapolis, Minn.

Please send me "Your Future" for which I enclose 6c in stamps.

Name.....

Age..... Occupation.....
(Write your address plainly in the margin)

America's Foremost School of Commercial Art

Money Making Opportunities

HELP WANTED

MONEY! Silvering Mirrors, Auto Lights, Radiators, tableware. Methods Free. Write Sprinkle, Plater, 98, Marion, Indiana.

SILVERING Mirrors, French plate. Easily learned; immense profits. Plans free. Wear Mirror Works, Excelsior Springs, Mo.

OUR genuine gold window sign letters are an excellent money-making proposition for handy men. Slann Sign System, East Bethune Avenue, Detroit, Michigan.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Address your inquiry to: Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

EMPLOYMENT in South America. We furnish classified addresses of 388 employers in Peru, Bolivia and Argentine for $1. South America Information Bureau, Portland, Ore.

MONEY Polychroming, also Silvering Mirrors. Sample and particulars free. Polychrome Works, 2604 East 40th, Kansas City, Mo.

EARN $1.20 an hour cutting blanks at home; spare time. Men only. Send addressed reply envelope. Goodyear 8m., 147 W. 23rd St., New York.

WANTED—Representatives in every factory in the United States. Popular Science Monthly, 250 Fourth Ave., New York.

MEN—Age 18-40, wanting Ry. Station-Office positions, $115-$250 month, free transportation, experience unnecessary. Write Baker, Supt., 42 Wainright, St. Louis.

EARN money weekly, spare time, home, addressing, mailing, music, circulars. Send 10c for music, information. New England Music Co., 118 Asylum St., Dept. S-14, Hartford, Conn.

SALESMEN, we pay larger commissions than any other Brush House in the country to men selling our line of Sanitary twisted-in Wire Brush. Sanitary Wire Grip Brush Co., 15 Mercer St., New York.

U. S. Government wants Railway Mail Clerks. $133 month. List positions free. Write immediately. Franklin Institute, Dept. F41, Rochester, N. Y.

MEN to Build Radio Sets for me in spare time. Leon Lambert, 670-H Kaufman Bldg., Wichita, Kansas.

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DISTRICT MANAGERS AND REPRESENTATIVES WANTED

MONEY-Making opportunity selling Radiolite system of charging batteries. Sells to battery stations, garages, auto-owners. Write for information and free demonstration offer. Radiolite Co., Dept. L, St. Paul, Minn.

WORLD'S fastest selling auto accessory! County distributors wanted; write to-day. G. L. W., Spring Oiler Co., San Diego, California.

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DOUBLE entry bookkeeping mastered in 60 hours; guaranteed; diploma. International Bookkeeping Institute, Springfield, Missouri, Desk 10.

LINCOLN-JEFFERSON University. Home Study in Academy College, Theological, Law, Music, Pharmacy, Business and Graduate schools, leading to degrees. Box G, Capitol Building, Chicago.

JOIN our home study club and save over 50 per cent on new or used correspondence courses. Particulars free. Courses bought. Students' Exchange, Dept. A, 47 West 42d St., New York.

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RAILWAY Mail, Postoffice Clerks, Carriers, Customs, and many other positions open—$1400-$2300 yearly. Write today for 36-page booklet showing how to obtain one of these desirable life positions. Chicago Civil Service College, T-70 Kesner Building, Chicago.

BE a detective. Excellent opportunity to earn big money, travel, thousands of dollars offered in rewards. Established 1909. Particulars free. Write to C. T. Ludwig, 424 Westover Bldg., Kansas City, Mo.

ALL men, women, boys, girls, 17 to 65, willing to accept Government Positions, $117-$250, traveling or stationary, write Mr. Ozment, 295, St. Louis, Mo., immediately.

FIREMEN, Brakemen, Baggagemen, Sleeping car, train porters (colored). $140-$200. Experience unnecessary. 838 Railway Bureau, East St. Louis, Ill.

DRAFTING, Tool Designing and Mathematics taught by mail; combined course or separate subjects. Harding School, Box H, Highland Park, Michigan.

ARTHOL Shorthand learned in four evenings. Full course seven dollars. Used everywhere. Sent on free trial. Particulars, Hollefreund's Institute, Desk S., Stratford, Ontario.

SALESMEN make money. My Science of Selling for beginners starts you, low cost, information free. Helm, 1411 Farwell Ave., Chicago.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Address your inquiry to: Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

More Money Making Opportunities on pages 6 to 26

MAN IS ON THE BRINK OF A MIGHTY DISCOVERY

Sir Oliver Lodge says he hopes this discovery will not become generally known until mankind has sufficient wisdom to handle the power that it will loosen. But scientists have already tapped this source of power! Not yet harnessed perhaps but yet plain enough that ANY AVERAGE PERSON can to a large extent demonstrate it in daily life.

With the use of this ENERGY you can accomplish anything humanly possible. This FACT has been proven by the actual experience of thousands of people during the last twelve months in whose hands we freely placed this amazing discovery. You not only "get the idea" but it applies itself to your affairs within a few days.

NOTHING IMPOSSIBLE

Literally thousands of people changed their lives almost overnight by this revelation.

With this secret Col. Adams of Salt Lake City made over $4,000 in a few days.

Unless this power will immediately and practically WORK for you, unless you can demonstrate it as clearly as a child demonstrates electricity by turning on the electric light, IT IS WORTH NOTHING TO YOU. For all men are not equal. Doubt, fear, suspicion, distrust, irresolution are chains that make slaves of many.

SEND NO MONEY—JUST THE COUPON

Use the coupon below and mail at once. When the Complete Course reaches you simply pay the postman only $2.85; 10,000 others have paid up to $25.00 for these same wonderful instructions. Put the simple principles to work immediately, and if, after five days, you decide that the remarkable course is as valuable to you as to others, keep the complete instructions for regular use. If not fully satisfied, simply return the Course and we will refund your money at once.

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Send me the Complete Instructions, "Making Men Think Your Way." I will pay the postman $2.85 on arrival and promise to try the Course five days.

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For a short time I will give tube radio set in handsome cabinet to men who enroll now, absolutely **FREE.** Send at once for my **FREE** wonder-book of inside Radio "dope."

A. G. MOHAUPT, Radio Engineer,
RADIO ASS'N OF AMERICA
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Dear Sir: Send me your FREE Radio Book and your limited plan without cost or obligation.

Name .....

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....Business Manager	.....Steam Engineer
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....Accountant & Auditor	.....Sanitary Engineer
....Bookkeeper	.....Surveyor & Mapping
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Meyer Both Company the largest Commercial Art Organization in the World offers you a practical training, based upon twenty-five years of success. This nationally known organization each year produces and sells to advertisers over 15,000 commercial drawings. This well paid profession equally open to men and women. Home study instruction.

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Ask the Advertising Manager of the leading newspapers in your city, about Meyer Both Company—let them tell you about us. Send four cents in stamps for illustrated book telling of the success of our students.

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IN your spare time writing show cards. No canvassing or soliciting. We instruct you fully. Write today without obligation for full particulars and free booklet.

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The little matter of 15 cents in stamps or coin will bring you on trial the PATHFINDER, an illustrated weekly, published at the Nation's capital, for the Nation; a magazine that prints all the news of the world and tells the truth and only the truth. If you want to keep posted this is your means. If you want a magazine in your home which is entertaining and wholesome, the PATHFINDER is yours. If you appreciate a paper which puts everything clearly, briefly—here it is. Send 15 cents to show that you might like such a magazine and we will send the PATHFINDER on probation 13 weeks—13 big issues. The 15 cents does not repay us, but we are glad to invest in new friends.

THE PATHFINDER, 672 Langdon Sta., Washington, D.C.

How I Average $12 a Day in RADIO WORK

By Howard Houston

"YES, Mr. Crosby, I'll have the set installed tonight . . . yes, all ready to 'listen-in' . . . sure you'll be able to get Washington by 9 o'clock."

Another hour and a half job! And another ten dollar bill in my pocket! It all seems like a dream. But let me tell you the whole story from the very start.

A few months ago, I was driving a bread wagon, selling bread to retail stores. I had a good route though, and if I do say so myself, I had built up a pretty good business. But try as I could thirty-five dollars a week was all I could make that job pay.

I'd be working there now if it hadn't been for Mary. We'd been "keeping company" for about two years, and everything was all set for our getting married as soon as I would be earning more money. But the old job didn't hold out much promise—and I didn't see how I was qualified for any other work that would pay more.

It was Mary who gave me the tip. "You can't earn big money," she said, "unless you're some kind of a specialist. Learn some line of work—become an expert in it." But what business, profession or trade was there that wasn't overcrowded? Where could an ambitious fellow stand a good chance to earn big money and get ahead. Stenographers, accountants, clerks—all down the line—every well established line of work was overcrowded, and the pay was small.

Then Mary said, "Why not find a new field?" That was a good thought. The men who went into the railroad business early "cleaned up." The same was true of the movie game, the automobile business—but what was the coming field? What new development was there that looked like a new promising industry?

We both jumped to our feet.

"RADIO."

Why hadn't we thought of it before? All around us was the evidence of the tremendous development of Radio. The broadcasting stations sprouting up all around—the rapid increase in Radio Stores—new radio manufacturing plants — everybody talking about the latest program. Radio had captured America almost overnight—and thousands of men who were on their toes were due to make fortunes out of it.

Thousands of Men Needed

The very next day after I had finished my route, I went to several radio business firms. "Sure, there was an opening. Oh, they'd pay big money—but did you know Radio?"

That was my cue. Learn Radio. Become a Radio Expert—and I did!

Well, that really is my whole story. I've only started. I've followed the path of least resistance. Sort of built up a business of my own installing, building, and repairing radio sets. Any small job pays me at least $5—and usually $10. I can easily make from $50 to $100 a week—and more as I get my work systematized.

What Mary and I have got to decide after our honeymoon—oh, yes, we are soon having a very quiet wedding—what we must decide after that—is which end of Radio will be best. You see, there are dozens of different kinds of work in this field, it's so big. I've already had several offers—one to take charge of a radio department, another with a broadcasting station, another to give radio entertainments, and a good offer as superintendent of construction in a radio plant.

"Ah! there's Washington coming in clear as a bell."

What we want to decide on is which will not only pay the most money now but will lead to the most rapid advancement in the future.

Easy to Learn Radio at Home in Spare Time

Just a word about this Radio business. Some fellows think you've got to have some training before you start to learn Radio. That's bunk. I didn't know the difference between an amplifier and a doorknob before I started. But let me give you a tip. Don't experiment with your radio course. Get the best. The National Radio Institute has been teaching Radio ever since 1914. The government recognizes its course by allowing credits to its graduates when they are trying for a license, so you see you can be confident you're getting the best training possible—and that means a lot.

This course is the only absolutely complete one now being offered which qualifies for a government first class commercial license. It gets you the bigger paying jobs in Radio.

Send for Free Book "RICH REWARDS IN RADIO"

Incidentally, the National Radio Institute publish a mighty interesting book on Radio. They send it out without cost to anyone who wants to learn about Radio. It is filled with facts, photos and figures, on The Radio Industry, and tells all about its course which quickly prepares you right at home in spare time for one of the big pay positions in Radio.

Take my advice—and Mary's—and send for that, no matter how little you know of Radio, or what your plans are. For a short time they are offering a reduced rate for those who enroll now. Act promptly and save money. Just mail the coupon today. Address the National Radio Institute, Dept. 12KA, Washington, D. C.

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Dept. 12KA, Washington, D. C.

Please send me without cost or obligation your Free Book, "Rich Rewards in Radio," which tells all about the opportunities in Radio, and how spare time study at home will qualify me for a big paying radio position. Also full details on your Free Employment service.

Name ..... Age .....

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The whole world of electricity is open to the *COYNE* trained Electrical Expert. Come to Chicago—the Electrical Center of the World. I pay your fare. Get your training at *COYNE*—the oldest, largest and best school of practical electricity in the country—endorsed by Electrical Industry. I do not offer a number of individual courses — I give you just one *complete* course so that you will be an *Electrical Expert* capable of commanding big pay. You can become an *Expert* and get big money in *ANY* branch of electricity if you come to *COYNE*.

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No books or useless theory. I train you on the greatest outlay of electrical apparatus of any institution in the country. I give you FREE complete Radio and Automotive courses. I also give you FREE a Life Membership which enables you to stay longer if you want or to come back at any time and take up any new work which is constantly being installed to keep my school the most modern at all times.

You Don't Need Education or Experience

COYNE gives you education and experience by *actual work*—that's why you don't need education or experience to start with.

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I help students to secure jobs to earn a good part of their living expenses while studying.

Send Coupon Now

Don't delay a minute—send that coupon **right now** for my big free catalog and full particulars of special offer. *ACT NOW!*

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Mr. H. C. LEWIS, Pres. Dear Sir:—Please send me free your big new catalog and full particulars on free railroad fare offer and two free courses.

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BUSINESS OPPORTUNITIES

WE start you in business, furnishing everything; men and women, $80.00 to $100.00 weekly operating our "New System Specialty Candy Factories" anywhere. Opportunity lifetime; booklet free. W. Hillyer Ragsdale, Drawer 19, East Orange, N. J.

STOP plodding! Be successful. Operate a tire repair shop. Make big profits in any locality. We teach you and furnish complete equipments, $100 up. Book of Opportunity free. Haywood's, 1306 South Oakley Avenue, Chicago.

USED correspondence courses sold, rented and exchanged. List free. (Courses bought.) Lee Mountain, Pisgah, Alabama.

FREE instruction book. Start Mail Order Business home evenings. Pier, 791 Cortlandt St., N. Y.

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GO into business for yourself. Make money marketing proprietary specialties under your own labels. We furnish everything and show you how. Booklet free. National Scientific Laboratories, 224 Monroe, Richmond, Virginia.

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YOUR wife can help you run a Mail Order Business. Keep your present job, too. Write, Leon Lambert, 670-D Volutsia, Wichita, Kansas.

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THE Great Wheat Secret. New book showing the cause of wheat swings and how to forecast them. Unequalled method for traders, speculators, millers. Eye-opening folder free; write today. Market Forecaster Co., Dept. B., Box 133, Kansas City, Mo.

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INCH Display Advertisement 166 Magazines Thrice $15. Year $50. Wood's Popular Service, Atlantic City.

FOR $10.00 we'll write three catchy classified order pulling advertisements that must bring you business. Rates of profitable magazines included. Mailing lists of mail order buyers, investors, agents, etc., at reasonable rates. Martinek Companies, Corona, N. Y.

MAKE money with your camera. (Lancaste), Box 436, Los Angeles.

ARE you old at forty? See our advertisement on page 148 of this issue. The Electro Thermal Company, 4038 Main St., Steubenville, Ohio.

ARTIFICIAL Marble sanitary flooring instructions, ornamental casting, concrete, plaster, papier-mache decorations, garden furniture, statuary, rubber-moulds. 15 years instructing the public, particulars and 200 illustrations free. Chris Mahler, Huntington, N. Y.

I MADE $100,000 as Real Estate Specialist. Free information tells how. American Business Builders, Dept. A-3410, 1133 Broadway, New York.

TATTOOING Pays Well—Free instruction with Supply Book. Remover formulas $1.00. "Waters," 1050 Randolph, Detroit.

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150 MONEY Making Plans Free! Wolverine Bureau, PS-I, Muskegon, Michigan.

SUCCEED With Your Own Products—Formulas, Processes. Different, Dependable, Profitable. Catalog Free. C. Thaxly Co., Washington, D. C.

A BUSINESS offering larger returns than usual lines. $100 starts you. Dept. R, Paul Kaye, 149 B'way, N. Y.

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More Money Making Opportunities on pages 6 to 26

Become an Expert Accountant

The profession that pays big incomes

There will always be a demand for well trained accountants—men whose training combines a knowledge of Auditing, Cost Accounting, Business Law, Organization, Management and Finance. Few professions offer better opportunities to men of ambition and intelligence. The tremendous business growth of this country has created a rich field for the expert.

Train at Home

Under the LaSalle Problem Method

The LaSalle Problem Method will train you by mail under the direct supervision of William B. Castenholz, A. M., C. P. A., former comptroller and instructor, University of Illinois, member of American Institute of Accountants, and a director of the National Association of Cost Accountants. He is assisted by a staff of 75 instructors—legal staff, organization and management specialists; business efficiency engineers, including 31 C. P. A's. You will be given whatever training, instruction or review on the subject of bookkeeping you may personally need—and without any extra expense to you. Our big free book on the accountancy profession fully explains how we train you from the ground up, according to your individual needs, from the simplest bookkeeping principles to the most advanced accounting problems. All text material supplied in the course has been especially prepared in clear, easy-to-understand language, so that you can readily master the principles by home study.

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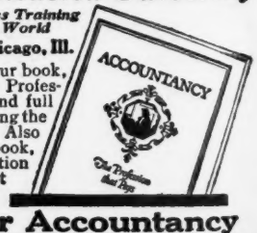

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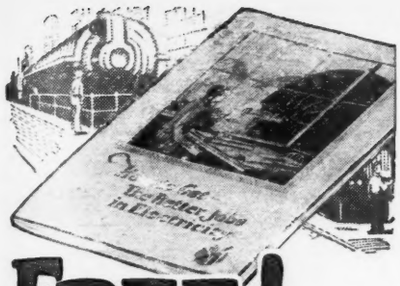

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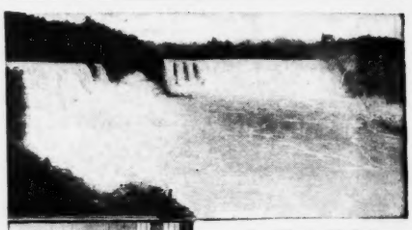

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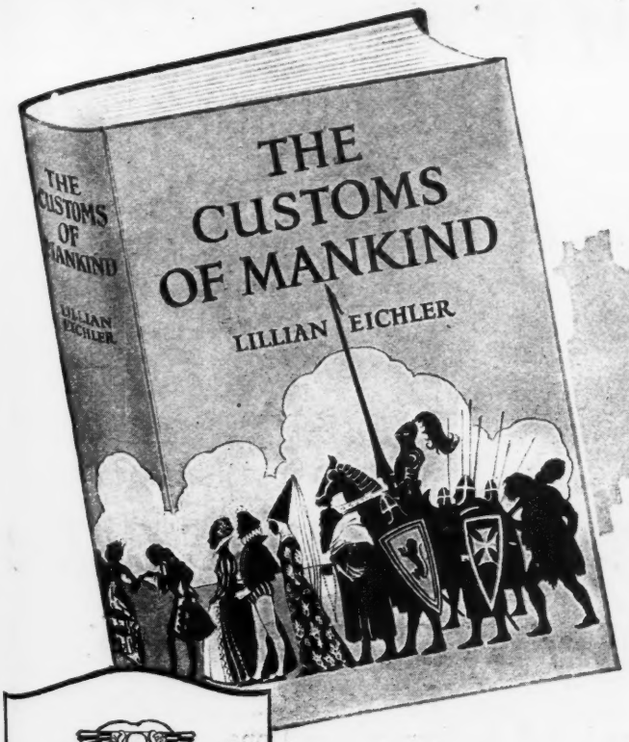

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BACK to the very cradle of human existence! All through the many ages and stages of man's development!

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—the king who kissed every girl in Normandy
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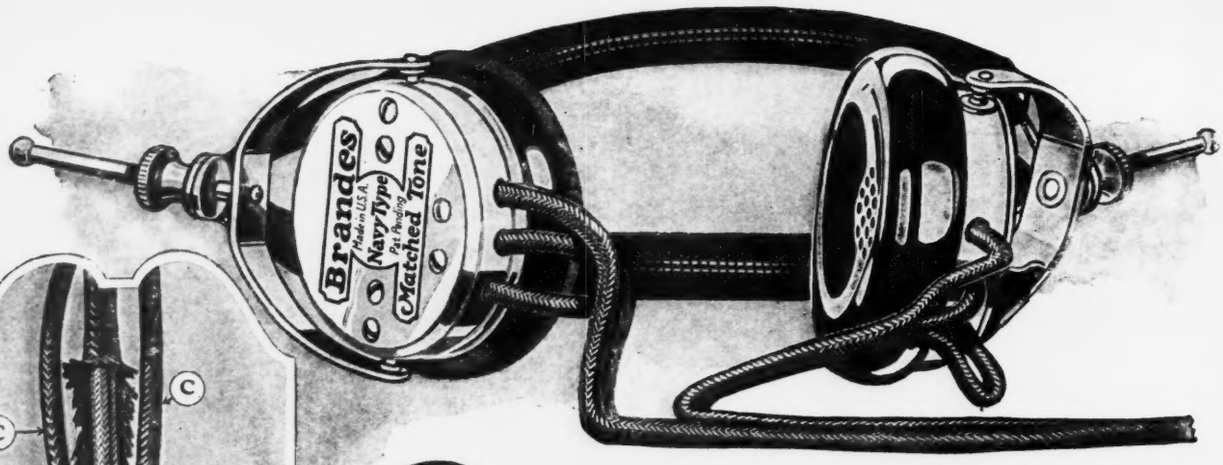
—why we say the stork brings babies
—how the kiss originated
—why the Egyptians mummified their dead
—why marriage-rings are worn
—the significance of orange blossoms on brides
—why black is the color of mourning
—why Chinese women compress their feet
—why the Egyptians worshipped the snake
—why cannibalism started



A—*Weather-proof cloth covering*

B—*Braided copper tinsel radio-frequency shield*

C—*Headset conductors (+ and -)*

Patented 5-12-24
(other patents pending)

3 *exclusive features of the* Navy Type Headset

TWO extra technical developments and one extra testing operation! These add clarity and distance. These are the three exclusive features which make the Brandes Navy Type the ideal long distance headset.

1.—The development of the braided copper tinsel radio-frequency shield [shown at the left] surrounds the conductor cords and grounds all radio-frequency currents which might cause detoning effects in the receivers. And in addition, it eliminates cord capacity.

2.—The use of inside terminals, so designed that the cords may be removed or replaced without taking off the cap of the receiver or in any way disturbing the perfectly matched tone.

3.—A very delicate testing operation matches the tone of the two receivers so that both ears hear exactly the same sound at the same instant.

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Superior *Matched Tone* Headset $6
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50¢ extra west of the Rockies
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The name to know in Radio

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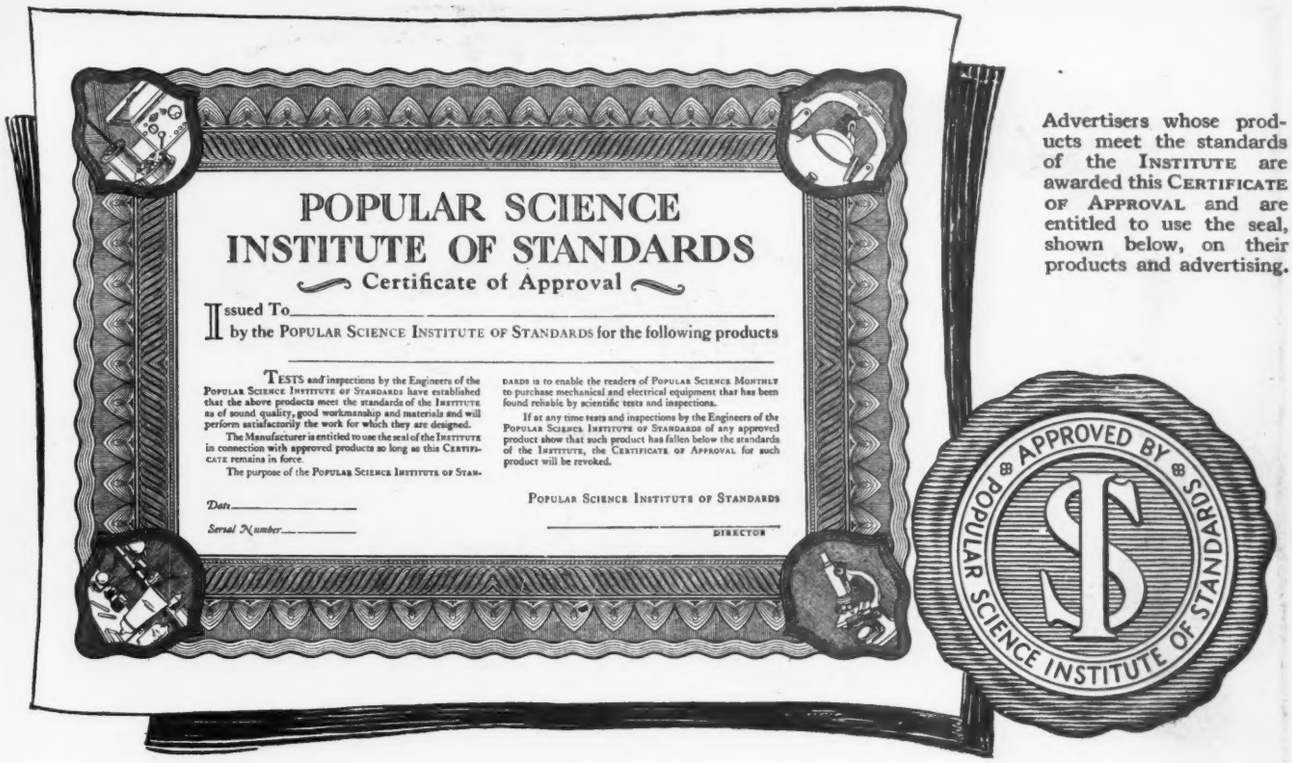
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By HAZEN G. TYLER, Sc.D., M.E.
Associate Director of the Popular Science Institute of Standards

IN THESE days of superlatives and exaggerated statements, most people go through life discounting all they hear and read. But the readers of POPULAR SCIENCE MONTHLY can accept all claims made in radio and tool advertisements at their full value. THE POPULAR SCIENCE INSTITUTE OF STANDARDS tests and approves every radio and tool product advertised. Then THE INSTITUTE goes a step further—it guarantees the absolute truth of the statements made concerning such products in POPULAR SCIENCE MONTHLY.

Before an advertisement is inserted in the magazine it is carefully gone over by the Director of THE INSTITUTE and the engineer who conducted the test on the product advertised. The first claims to be checked are the technical assertions concerning the advertised article. Any technical statements that do not agree with the results of our tests are eliminated or modified.

Then all superlatives are weeded out. This applies to either flat superlatives or insinuated superlatives. Our tests are comparative, but as THE INSTITUTE tests only those products offered for advertising in POPULAR SCIENCE MONTHLY, this does not, obviously, include every product in any certain line of manufacture. And unless exhaustive comparative tests were made on *every* product, we could not truthfully say which is the best.

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THE PUBLISHERS.

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It is not a bureau for the establishment of standards whereby the products of competitive concerns can be compared and the supreme product in each of the many lines of manufacture picked. Therefore, when a tool manufacturer makes the statement in his advertising that his is "the finest tool made," THE INSTITUTE cannot put its seal of approval on such a claim.

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Only tool and radio products *specifically* advertised in POPULAR SCIENCE MONTHLY are tested and approved by THE INSTITUTE. The approval does not include products advertised through radio and tool catalogs.

Send for list of Approved Products

POPULAR SCIENCE MONTHLY will be glad to furnish a list of Radio and Tool Manufacturers whose products have been approved by THE INSTITUTE.

THE GREBE SYNCHROPHASE

TRADE MARK

"It is only when the cold season comes that we know the pine and cypress to be evergreens."
—Confucius

In the coming cold season be not surpassed by thy neighbor—set the pace with your Grebe Synchrophase.

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A BROADCAST Receiver that marks another long step forward in radio design and establishes a new set of standards in craftsmanship.

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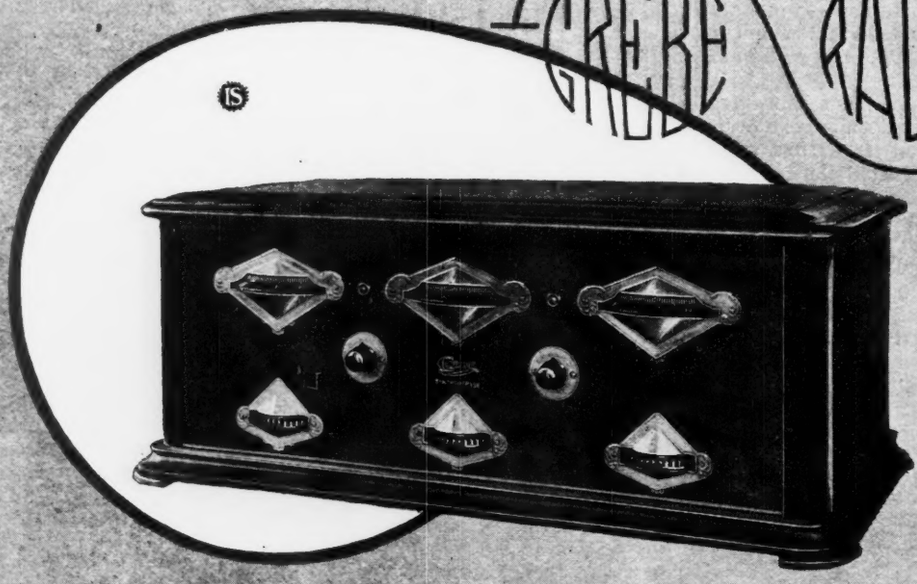


POPULAR SCIENCE MONTHLY
SUMNER N. BLOSSOM, Editor
October, 1924

The World's Greatest Adventure, a Triumph for the Airplane

By Major William N. Hensley, Jr., U. S. A.

If you have any doubts about the commercial future of the airplane, this absorbing article by the Commander of Mitchel Field, N. Y., will soon dispel them. In telling the dramatic story of how the American airplane has proved itself, he speaks with the authority of one who is familiar with every phase of aviation science. Not only is he the commanding officer of a great aviation center, a skilful airplane pilot, an engineer, and inventor, but he is one of the foremost airship pilots of the U. S. Army Air Service.

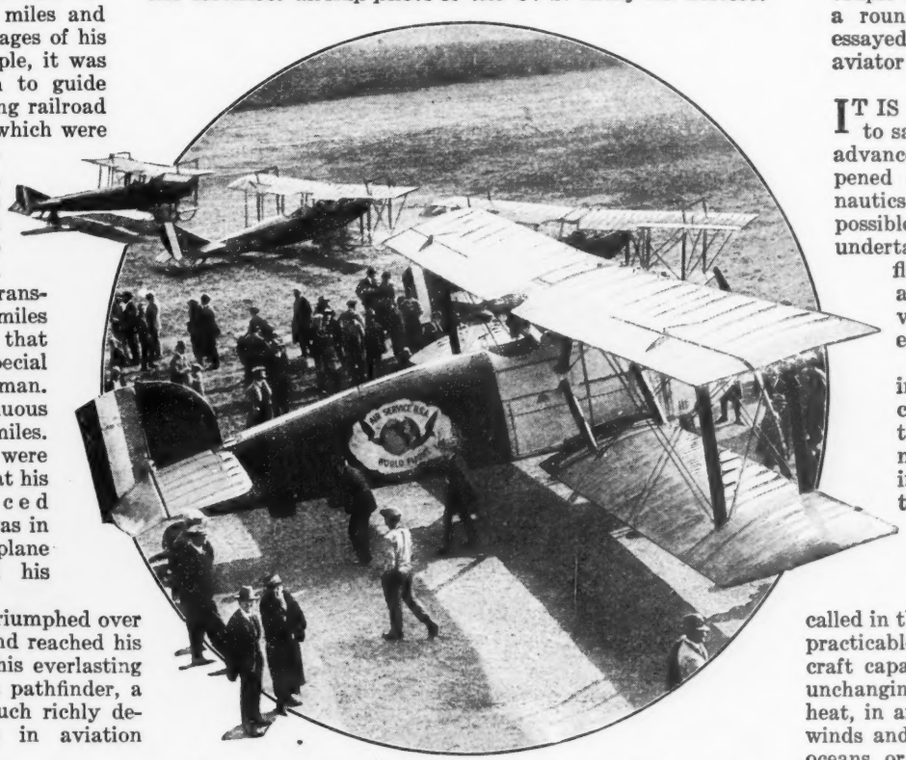
IN 1911 Cal Rodgers made the first airplane flight across the American continent. His trip—from New York to Pasadena, Calif.—took 54 days, and was accomplished only by the most amazing exertions and ingenuities. For miles and miles at certain stages of his journey, for example, it was necessary for him to guide himself by following railroad cars, the roofs of which were painted with symbols that he could recognize from the air. Here and there he had to place his craft on a flat car to be transported for a few miles over territory that seemed to offer especial hazards to an airman. His longest continuous flight was 133 miles. So many repairs were made to his craft at his innumerable forced landings that it was in a virtually rebuilt plane that he finished his flight.

That Rodgers triumphed over such difficulties and reached his destination is to his everlasting credit. He was a pathfinder, a pioneer, and as such richly deserves his place in aviation history.

SUPPOSE, though, as Rodgers stepped from his plane at the end of his journey, some one had offered the prediction that within a dozen years airmen would traverse approximately the same route in a single day? Suppose the speaker suggested that within a dozen years aviators would be circling the globe?

Such a man, I am sure, would have been regarded as an impractical dreamer, if not a fit candidate for the madhouse. To have suggested at that time even that the airplane some day would match a railroad locomotive in efficiency would have been an absurdity.

And yet these things are not merely admitted possibilities today; they are actualities. The modern airplane already has left the locomotive far behind. To a skilled airman today a transcontinental flight means scarcely more than a trip of 100 miles over concrete highways does to the owner of a well-conditioned automobile. Every day mail is carried by airplane between New York and San Francisco. Only a few weeks ago Lieutenant Maughan flew from the Atlantic to the Pacific between daylight and dark—the time that would be consumed by a fast railroad train in crossing a couple of states. And even a round-the-world flight is essayed by the present-day aviator with no misgivings.



In the foreground is the first of the Douglas air cruisers designed and built for the round-the-world flight of Army airmen by Donald Douglas, an American engineer. Their wonderful performances over land and sea, in all kinds of weather, and their victories over the tremendous obstacles of the world's greatest adventure, have been due in large measure, says Major Hensley, to the Liberty Motor—an engine that is a triumph of American industry, ingenuity and patience. During the war the average airplane flight was two hours for a distance of 150 miles. Today the world cruisers have proved capable of 500 or 1000 miles at a hop, continuously. In endurance and efficiency they have left the steam locomotive far behind

IT IS probably unnecessary to say that some amazing advances must have happened in the field of aeronautics since 1911, to make possible such an epochal undertaking as the world flight of the U. S. Army aviators, the most adventurous air voyage ever attempted by man.

Those whose interest in aviation is only casual, have jumped to the conclusion that most drastic changes in design and construction must have been made to transform the airplane from a "flaming coffin," as it was frequently called in the past, into a speedy, practicable, safe, dependable craft capable of operating with unchanging efficiency in tropic heat, in arctic cold, in the high winds and fogs of the northern oceans, or in the dead calms of southern seas. I know this to be the opinion of the layman, for many have expressed it to me since the round-the-world fliers "hopped off" from Santa Monica, Calif., on the first leg of their journey.

It may be surprising, then, for me to say that, in my opinion, a development in one single phase of aviation, more than any other factor, has been responsible for the really amazing success of the round-the-world flight. This development, which foreshadows a speedy utilization of the airplane for general commercial purposes, is the Liberty Motor.

The story of the Liberty motor has elements that are actually dramatic. It

When the U. S. Army aviators hopped off from Santa Monica, Calif., just west of Los Angeles, on March 17, for their flight around the world, they embarked on one of the most remarkable adventures ever undertaken by man on land or sea, or in the air—an achievement that marks a new epoch in world commerce. The map above shows the path of the modern Magellans, a distance of from 25,000 to 26,000 miles, over which they have proved the airplane to be a speedy, safe, and dependable craft. At the right is Lieut. Lowell H. Smith, flight commander

is the story of Cinderella, of the Ugly Duckling, the familiar novelist's theme of the poor young hero who surmounts incredible obstacles, worked out once more in actuality.

The Liberty motor, as you may recall, was developed first as a war measure, and was built in large quantity during the intensive effort to equip the American Expeditionary Forces. To say that the motor was unsatisfactory to Government aviation experts is to express the thing mildly. New flaws and defects in the apparatus were discovered almost daily.

I am probably safe in saying that had there been available to the Army Air Service another type of motor, had there been an appropriation sufficient to finance the development of a new type, the Liberty motor would have been scrapped as soon as the war was over. It happened, though, that neither was the case. Something around 10,000 Liberty motors were on hand, and, under the circumstances, the obvious and sensible thing was to make the best of them.

And it was then that the Ugly Duckling began to evidence unmistakable

(*Continued on page 141*)

A New Era in Automobile Construction

How your car is put under the microscope, tested, analyzed, and assayed in a great research laboratory—Astonishing plans to make your motoring safer and more comfortable in the future—A dramatic story of science and business

By Edward Mott Woolley

"IF BY some magic, you could bring out of the future the automobile of 10 years hence, and drive it today through our streets of Dayton, you would find yourself the center of incredulity and astonishment," said Charles F. Kettering, president of the General Motors Research Corporation, which has its great experimental plant near that Ohio city. "But if you drove it out to our laboratory, our research men would be quite ready to accept it.

"The scientist lives among figments often years ahead of his age," Mr. Kettering went on, "and here in our scientific workshop we know that the present cycle of automobile design and capacity must in time run out.

"Various causes already are operating to bring this about. First, refiners are at their wits' end to produce enough gasoline to operate the so-called modern automobile and truck. The wanton consumption of horsepower in propelling heavy motor vehicles portends disaster. Investigations have shown that the average automobile carries on its every-day travels the equivalent of only 1½ persons. The streets of our large cities are absurdly congested with these great empty vehicles. The problem is typified by the recent attempt of New York to prevent vacant taxicabs from cruising the streets for passengers.

"The wise automobile manufacturer reads, along the road of progress, signs that point the way to a smaller, lighter, less expensive car, signs that point the way to a new era in automobile construction.

"I should not like to build in your mind, however, any definite picture of the future car," he added. "It would be a guess to predict, for example, that the shift would be done away with—that you would have no gears to worry you. Inventors long have sought such a millennium for gas-driven cars. The electric shift and hydraulic transmission already have been tried, with a variety of troubles.

"I should hesitate to prophesy that the engine would take a radically different form, that cooling would be accomplished in new ways, or that some new propelling force might be in use. Many things are possible, and here in this laboratory we are searching the future with our knowledge of today. We have built entire cars for experimental purposes and tried them out on the road; but for the most part we are hunting piecemeal for better ways of making automobiles, and for better parts of lighter weight. Anything connected with the improvement of automobiles is in line with our work.

"We have 300 engineers constantly on the job. It does not matter whether we get ideas on frictionless bearings, new materials for brake bands, better principles of ignition, new alloys, or original paint. No matter how grotesque or intangible a thought seems at its inception, it carries a possibility. We don't want to think in little orbits. We would rather begin in the big orbit and compress it into the practicable as experiment compels us, than to think in small circles that never get any bigger."

I had gone to Dayton for POPULAR SCIENCE MONTHLY to talk with Mr. Kettering, and to see one of the greatest of research institutions. Six miles out of that city I found the laboratories, housed in a building 1000 feet long, part of which was used during the war for making airplanes.

This great workshop today contains the embryonic car of a decade hence. In all of its far-reaching departments are crude, undeveloped parts of this car of the future. The rooms are haunted not only by engineers, but by all the shadowy possibilities of inventive imagination.

Little by little the assembling process goes on. Although the laboratories contain all the essentials necessary for the building of automobiles, the tremendous rush of the modern factory is lacking. Leisurely science takes the place of speeding production. Chemistry, physics, mechanics, metallurgy, electricity, and allied sciences all join forces here.

EVERY research laboratory works on possibilities not yet realized. Research men are guarded in discussing them. Mr. Kettering referred to science merely in a general way, with no special reference to his laboratory, when he made a guess that new substances would be discovered that would have a bearing on automobiles and other things. As an example, he cited the possibility of flexible glass. Indeed, a substance already has come into use for automobile windows that hints at flexible glass in reality.

I am thrown on my own responsibility when I suggest that science has not reached the end of its work with rubber, for example. Is it too much to imagine that we may have an airless tire as resilient as the present pneumatic one?

Or that alloys will be found to render steel immune to crystallization—literally unbreakable?

That the shifting of gears in gasoline cars will be wholly eliminated? Today we are at the peak of an engineering attack upon this enigma.

That some new fuel or other power will come out of a future still unexplored?

That new paints and other finishes will be found as radically different as a

Today's Mechanical Marvels Eclipsed Tomorrow

"TOMORROW'S car will compare with today's as does a locomotive searchlight with a tallow candle," Charles F. Kettering, head of the General Motors Research Corporation, told Mr. Woolley.

"But don't forget that the machine we are experimenting with is already marvelous beyond conception. For instance, the engines of some cars fire 16,000 shots a minute, while the most rapid firing gun fires less than 1250. Every one of these 16,000 explosions is caused by a spark delivered on schedule time!

"This is the wonderful machine we are seeking to improve."

recently discovered paint differs from that of yesteryear?

That a gallon of gasoline will carry a car 50 or even 100 miles, or that new lubricating contrivances will be devised to cut down friction tremendously? The present frictionless bearing, I believe, is accomplished by absorption of oil into the bearings?

That lights will be invented no more dazzling than daylight?

I cannot put all these possibilities into Mr. Kettering's mouth. They suggest themselves to me out of the very atmosphere of that great research laboratory.

Charles F. Kettering, who, as president of the General Motors Research Laboratory, is directing the efforts of a large staff of engineers seeking to answer the question: What sort of automobiles are we to have in the future? Through exhaustive research they are trying to determine just how the present-day automobile may be improved, and what changes are necessary that our cars may be safer and more comfortable

I asked Mr. Kettering about balloon tires and their probable effect on the design and weight of the future automobile. He preferred not to discuss them beyond saying that they gave evidence of possibilities in that direction.

HERE I am reduced again to my individual responsibility. Basing my premises merely on the general feeling in automotive circles, it would appear that balloon tires are perhaps the outstanding development just now in the fashioning of the coming car. What could have a greater influence on car weight, and consequently on its design, than tires that carry a car on an air pressure so greatly diminished? So it seems that there must come radical changes in the character of many heavy-car parts—the steering gear, for instance.

In like manner, every such distinct departure from conventional standards upsets the automobile all through.

To the user, who is not so much interested in the wonders of science and mechanics, the great gain in all this research will be lowered cost.

About the first thing they showed me in this huge series of laboratories was the section fitted with gas-heated or electric furnaces, in which are carried on the experiments in the heat treatment of metal.

"A few decades ago, steel and iron were simply steel and iron," said Mr. Kettering. "So far as the consumer was concerned, nothing was known of the composition. Steel manufacturers had their own ideas, but their formulas were secret.

"The railroads were using extraordinarily heavy metal parts because they lacked knowledge of the strength to be obtained through heat treatment and alloys. It is said that a college professor out of a job talked Andrew Carnegie into employing him to do research work in steel — out of which came unexpected scientific information.

"With the coming of the automobile the need developed rapidly for metals that would withstand unheard-of blows, pulls and torsions. The metals on the market were wholly unfit. Thus there came about a new scientific research not only into the composition of metals, but into their molecular structure as affected by heat treatment.

"The effect of alloys, in a word, may be likened to that of cement. You might say that they fill the gaps in the molecular formation of the metal, decreasing crystallization and breakage.

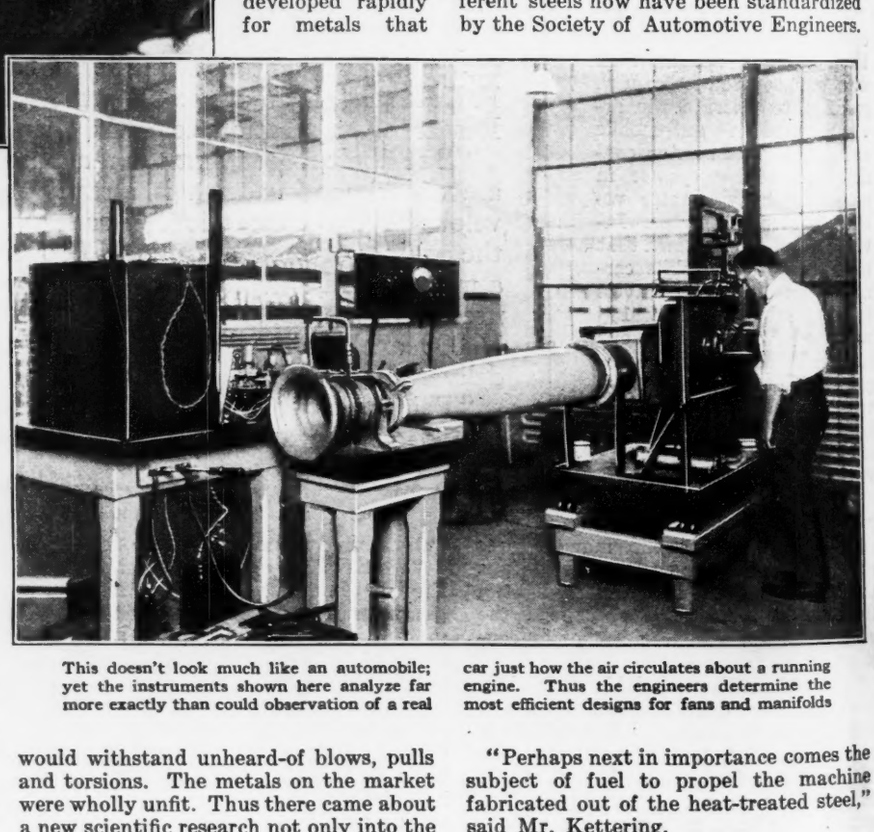
"Up to that time this sort of thing had been almost all guesswork. The heater would squint through a peephole into the furnace, and when the piece of metal was 'cherry red,' or a particular tinge of blue, he would take it out. On these colors depended the strength and toughness of the part.

"SCIENCE has revolutionized heat treatment so that today the exact temperature for each particular use is standardized. We know just how long a given automobile part should remain in the furnace at a specified temperature—perhaps 2000 degrees or more.

"We have electrical devices for maintaining this temperature automatically, and recording devices that show the pyrometer man whether or not they are working properly.

"Without these discoveries in the heat treatment of metal it would have been impossible to develop the modern automobile. The axles, springs, and steering gear would not stand up under the terrific strains.

"There are now about 15 varieties or compositions of steel in a single automobile, and the industry has been steadily working toward the standardization of varieties, so that every part can be duplicated again and again; so that axle and spring strength will not be sporadic, and parts can be manufactured month after month and year after year with the same qualities of endurance. Sixty different steels now have been standardized by the Society of Automotive Engineers.



This doesn't look much like an automobile; yet the instruments shown here analyze far more exactly than could observation of a real car just how the air circulates about a running engine. Thus the engineers determine the most efficient designs for fans and manifolds

"Perhaps next in importance comes the subject of fuel to propel the machine fabricated out of the heat-treated steel," said Mr. Kettering.

"Ten years ago gasoline was largely gasoline. Five years ago it was not so much gasoline. Today the overwhelming demand for automobile fuel is being met only by the utilization of gasoline of

greatly reduced power and efficiency.

"This is not a reflection on the gasoline manufacturers. On the contrary, it is only through their continued scientific work that the demand of today is met at all. Except for gasoline chemistry, the present type of automobile would have been useless long ago. The invention of the so-called cracking process, through which petroleum was made to yield much more gasoline, was one of the accomplishments that kept the supply up to the insatiable demand. In 1923 the consumption of gasoline in the United States was 7,000,000,000 gallons—more than doubling since 1918!

"THE problem of the automobile manufacturer has been to produce an ever-changing type of carburetor that would utilize the constantly lowering grade of fuel.

"All automobile manufacturers want a carburetor that will start the engine instantly at 10 below zero, with never a cough.

"The carburetor, however, is only one element," Mr. Kettering explained. "In improving the carburetor and in engine studies in general, we began to fathom the mystery of the knock.

"To the ordinary driver the knocking of an automobile engine is a fact bounded by the deepest mystery — a mystery that he never could solve. He takes it to the ordinary garage man, who looks wise, but who knows little more about it than the user.

"The scientific man, however, found the cause of the knock and understood perfectly the how and why of it But to discover a way of stopping it consumed several years of research. Thomas C. Midgely, Jr., vice-president of the General Motors Chemical Company, happens to be the man who found how to stop the knock by the use of ethyl gas, and how to make the process a commercial possibility.

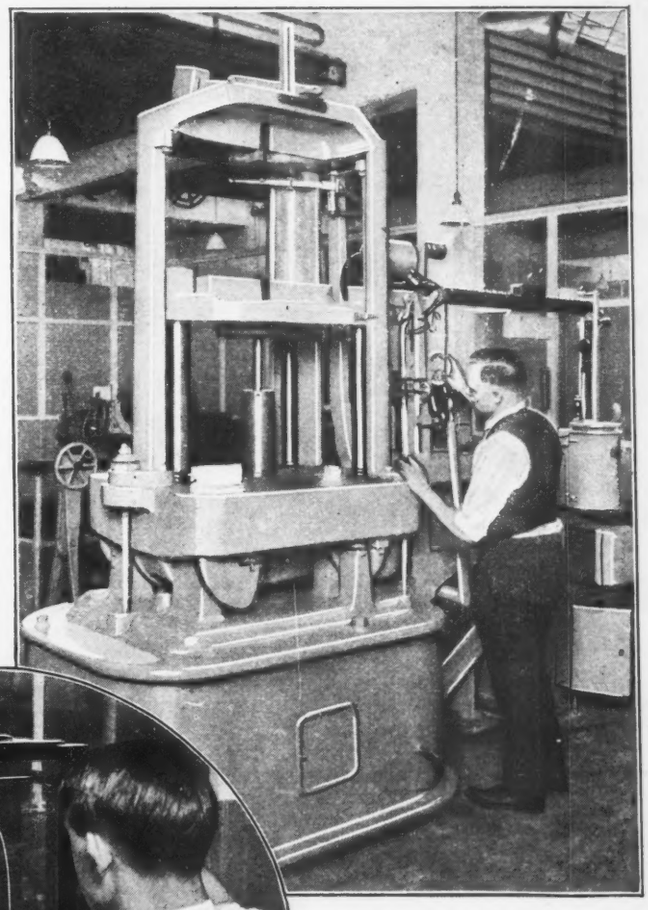
"THE automobile industry always has been a race between production of cars and the production of fuel to run the cars. We must do all in our power to conserve fuel by getting everything out of it."

Incidentally, talking about the conservation of fuel, Mr. Kettering offered this opinion: "Unless I lose my guess, within 10 years, all railroads will be operating their trains with internal combustion engines. This will come about unless the makers of steam engines evolve radical improvements."

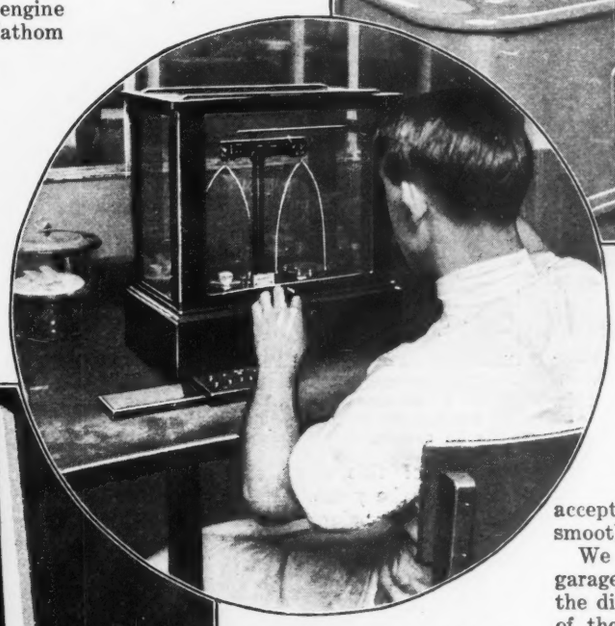
They took me into one of the laboratories and gave a demonstration of ethyl gas with a gasoline engine. On a fair quality of gasoline the engine ran smoothly; but when the fuel pipe was shifted to a mixture containing half gasoline and half kerosene, in a few seconds it began to knock tremendously.

Then one of Mr. Kettering's men took a common medicine dropper and dipped it into a small black bottle of ethyl fluid. He placed the tip of the dropper where the engine could sniff the magic gas, and in a few more seconds it calmed down and ran quietly for a minute. Then the violent knocking indicated its appeal for more of the fluid.

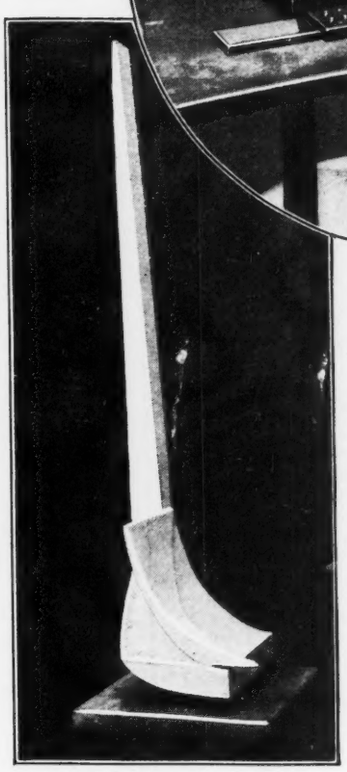
Next, a small quantity of the ethyl fluid was placed in the mixture of gasoline and kerosene, turning it red orange; and the engine now accepted this charmed fuel and ran smoothly again.



In the automotive laboratory, machines such as this test to destruction all materials used in building motor-cars, from the fabric that the tops are made of, the seats, and floor coverings, to the steel that goes into the crankshafts. The materials are pressed, torn and twisted until they give way, to determine their strength and quality, and so make your automobile safer to ride in



Probably you never think of the chemistry of the automobile, but to the research engineer it is of prime importance. Thus, the weighing in delicate scales of infinitesimal samples of chemicals from exhaust gases, or bits of dust that might be sucked in by the carburetor and enter the cylinders, might lead to important discoveries for improving the car design



This odd-looking object is an engineer's three-dimensional curve representing the explosions in a certain type of engine cylinder, expressed in terms of pressure, volume, and quantity

We came to the large laboratory garage in which all the employees bear the distinction of knowing the very soul of the automobile. Standing about on the expansive cement floor were a number of mud-spattered cars—natives of the laboratories, some of them, and unnamed. They were specially built cars, sent out to search the future Mr. Kettering has talked about. From them, perhaps, will evolve the new type of car.

"IT IS no conventional road that these cars travel," Mr. Kettering told me. "The ordinary garage road test is anything but scientific, but here at Dayton we hang thoroughly scientific research on the most grueling experiences out on the highway. The cars we use for our researches are kept out 24 hours a day.

"A typical road circuit includes the best and the worst roads we can find around Dayton, over a circuitous route of 86 miles. The driver picks out the roughest hills, and all the ruts and bumps he can find. He drives the car hard and keeps it going, so that altogether it covers from 200 to 300 miles a day.

"During this period the driver makes

(*Continued on page 148*)

Here is Epinard, the "superhorse" from France, which has crossed the sea to meet America's best on strange battlegrounds in a series of international races

Why the Fastest

Changes in Atmosphere

By Stanley G. Zinke, M.D.

ABOUT a year ago a three-year-old racehorse named Papyrus, regarded as England's best horse of that age after his victory in the famous Derby, was brought to this country to engage in an international match race with the best American three-year-old. Undoubtedly you will recall that Zev, the colt chosen to represent the United States, won the race handily at Belmont Park, N. Y.

Probably you will recall also that there was some difference of opinion at the time as to whether Zev should have been selected to uphold the turf honors of this country in the international race, some racing experts holding that not Zev, but a colt named My Own, which had won every race of its three-year-old season, was America's best three-year-old. Even after Zev's victory over Papyrus, the controversy waxed warm, and to settle the matter, a match race was arranged between Zev and My Own at Latonia, Ky.

In this latter race a third horse—a Kentucky colt named In Memoriam, regarded as little more than a pacemaker—was an easy winner, defeating Zev by six lengths and My Own by 16. To racing experts it was one of the most extraordinary upsets of turf history.

MANY excuses were made for Zev. Nobody, though, that I recall, suggested what I believe to be the real reason for In Memoriam's victory, which was—weather. Few persons realize the extreme sensitiveness of racehorses to weather changes, and the effect of weather upon the condition of the track itself. I have yet to meet a racing expert who recognizes the disturbing or stimulating effects of certain weather conditions.

In the course of my investigations into the relationship between atmosphere and man, I had occasion to study the racehorse in his native element for several months, watching his behavior under various atmospheric conditions. I found that one factor stood out—atmospheric pressure.

The importance of atmospheric pressure—with regard to the physical condition of both man and beast—depends on the fact that the body must maintain a pressure of gases within the blood vessels exactly equal to the pressure exercised by the air. A disturbance of this equilibrium stirs up trouble—if the pressure of the gases in the blood falls below that of the atmosphere, the vessels will collapse or contract, and if it rises above that of the air, they will expand or dilate.

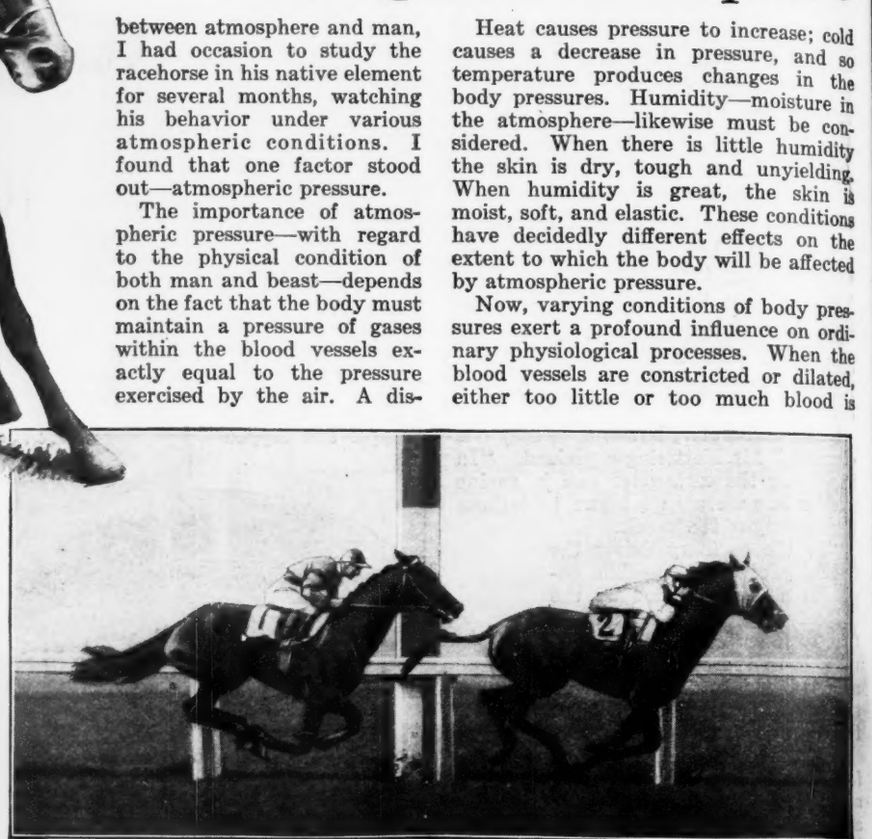
Heat causes pressure to increase; cold causes a decrease in pressure, and so temperature produces changes in the body pressures. Humidity—moisture in the atmosphere—likewise must be considered. When there is little humidity the skin is dry, tough and unyielding. When humidity is great, the skin is moist, soft, and elastic. These conditions have decidedly different effects on the extent to which the body will be affected by atmospheric pressure.

Now, varying conditions of body pressures exert a profound influence on ordinary physiological processes. When the blood vessels are constricted or dilated, either too little or too much blood is admitted, and there is consequent disturbance of the bodily functions. Weakness or exhaustion from too little blood is one extreme condition; congestion, inflammation, or rupture is the other.

Now, let us see how all of this affected the three horses that contested in the Kentucky match race I mentioned.

ON THE day of the race, pressure was low and falling, temperature and humidity rising, and it rained lightly before the race. The time of the race was slow, showing that the weather affected all three horses. The pressure at Latonia is normally about .6 inch lower than that at sea level, the pressure under which Zev and My Own were accustomed to running. Against a Kentucky horse accustomed to a normally lower atmospheric pressure than they, both of them were hopelessly handicapped before the start.

A somewhat similar instance was the last Kentucky Derby. This was run on a much better day, but pressure once again was falling. The four leading horses, Black Gold, Chilhowee, Bean Butler and Altawood, all were



Finish of the match race at Belmont Park, N. Y., between Papyrus, English Derby winner, and Zev, the pick of American three-year-olds, showing Zev winning handily. Zev's later defeat by the Kentucky colt, In Memoriam, at Latonia was due, Doctor Zinke says, to the lower atmospheric pressure in Kentucky, to which Zev was unaccustomed

Can Epinard Win in Kentucky?

THE performances of Epinard, the four-year-old "superhorse" from France, which is competing with America's best in a series of international races, will be watched with increased interest in the light of Doctor Zinke's remarkable theories regarding the effect of weather conditions on the physical efficiency of man and animal alike.

Atmospheric conditions on the eastern seaboard of the United States, where Epinard has been training, are very similar to those in France; therefore his acclimatization should be speedy, so far as the Atlantic coast is concerned. But will he be able to run at his best when he reaches the lower atmospheric pressure of the Kentucky mountains? Or will history repeat itself and will the great French horse succumb, like many an Eastern crack racehorse, to the onslaught of Kentucky thoroughbreds?

Doctor Zinke speaks with the authority of an eminent physician and scientist who has made an exhaustive study of his subject.

What he says is of revolutionary importance, not only because it opens up an entirely new phase of one of America's most fascinating sports, but because his discoveries may have a profound effect on human health and energy.—THE EDITOR.

Racehorses Lose

Produce Real Handicaps

After winning the $10,000 Maryland Handicap last year, the Eastern three-year-old, My Own, lost to In Memoriam by 16 lengths in the higher altitude of Latonia, Ky.

horses that had been racing at Louisville, Ky., or had come *down* for the race from the more elevated territory about Lexington, where, of course, atmospheric pressure is normally low. The best that any Eastern horse could do in the Derby was fifth, and the time of the race was two seconds slower than the track record.

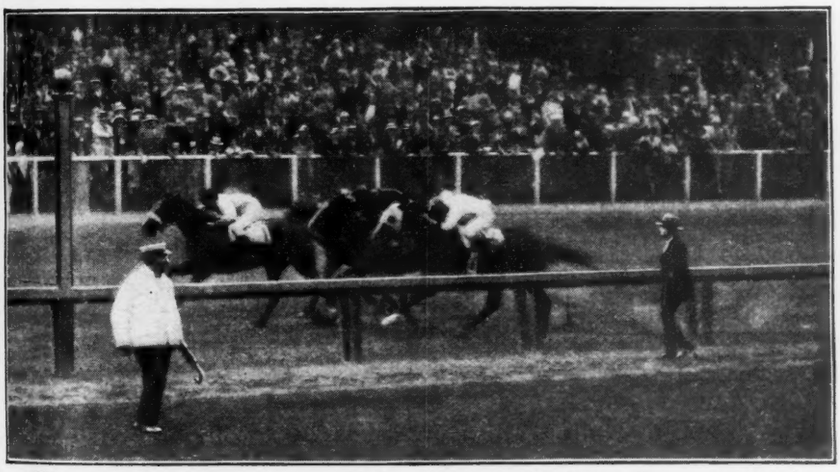
AN EVEN more startling example was a race at Latonia not long ago in which five horses contested—three from Kentucky and two from the East. Though the Eastern horses—Martingale and Rialto—were high class colts and appeared to have the race between them, the three native entrants beat them by six or eight lengths, the difference, as I compute it, that the change of altitude makes between Eastern and Kentucky horses of the same class when they race together at the latter place.

Race after race of this sort could be cited — and always with the same results.

When Kentucky horses go to the sea-level tracks of New York and Maryland, however, there is a different story to tell. Their efficiency—both speed and endurance—is increased temporarily; then they slacken up. This is because the blood of both men and animals living at high altitudes has a higher percentage of reserve oxygen than the blood of those living in the lowlands. Coming to a lower level, this reserve is pressed into service by the higher pressures, but it is eventually dissipated, and then the man or animal has greater difficulty in sustaining the greater weight of the air.

In the pioneer days of our southwestern states the Indians would bring their scraggy ponies down from the heights and walk away with the best horses the white settlers owned. In certain regions of South America, where racing is a favorite sport, the racing authorities have learned that lowland horses stand no chance with a recently arrived highlander. Consequently, they require that mountain horses must be at the tracks for days in advance of the events in which they are entered.

There was an example of the temporary increase of efficiency that comes to a highland horse visiting the sea level on the very same day that In Memoriam was taking the measure of Zev and My Own. The Kentucky colt, Beau Butler, defeated a field of crack two-year-olds at a Maryland track, winning a purse of more than $40,000 Again, just a short time before the Kentucky Derby of this year, we find a four-year-old Kentucky mare, Chacolet, making a jump down to Maryland and carrying off a purse of about the same size. Several weeks later, though, Chacolet failed dismally in the Suburban Handicap at Belmont Park, N. Y., due probably to the fact that she had remained at sea level beyond the time when her reserve supply of oxygen was available.



This remarkable photograph shows Black Gold leading by a length at the finish of the last Kentucky Derby at Churchill Downs. The four leading horses all were accustomed to Kentucky atmosphere, in which the best that any Eastern horse could do was fifth

During the entire month of August every year there is a race meeting held at Saratoga Springs, N. Y., in which the best of the Kentucky and Canadian horses meet the best of the Eastern stables for large purses. Eastern horses meet frequent defeat at this track from Kentucky and Canadian horses that they seem to outclass. Turf followers always have been at a loss to account for the many "form reversals" of the Saratoga meeting, but I think we have the explanation in weather and climate—and particularly in atmospheric pressure.

When horses that have been campaigning at the New York and Maryland tracks go to Saratoga, they go to a place of higher altitude. Kentuckians and Canadians, on the other hand, descend from a higher altitude to a lower. This gives the Kentuckians and Canadians a marked advantage at the beginning, when it is that they score most of their victories. Later, though, the Eastern horses, improving in the higher altitude, come into their own and recoup the earlier misfortunes of their owners.

LIKE young children, young horses—those up to three years old—are extremely sensitive to weather changes. Likewise finely trained horses—particularly those of fine breeding—are far more sensitive to changes than are less thoroughly trained horses of poorer grade. Training is particularly severe on the younger horses. It removes fat, which is an insulator, a fuel, and a storehouse for nitrogen, the element upon which pressure depends.

Young horses stand cold better than aged animals, because their heat-producing qualities are better. Younger horses, because of the activity of their sweat glands, prefer drier air, while the older animals, with their tough, dry hides, appreciate humidity. Consequently you will find the younger horses performing best on cool, dry days and the older ones on warm, humid days, although both young and old do better under high pressure than low.

Even on cool, dry days, however, and with a big advantage in weight, a young horse rarely will beat an older horse in the spring. The fact that the body of the younger horse is not yet attuned to the variable weather of the spring probably is the principal reason for this.

So far as I know, even the most intelligent racegoers take scant notice of these highly important weather factors in estimating the chances of horses in the various races. Is it any wonder, then, that with the invisible influence of weather at work in addition to the factors that can be recognized, the number of persons who can win at the racing game is exceedingly small?

Rebuilding the Portal that Moses Entered

SIX huge pillars that are believed to have supported the main archway to the throne-room of the ancient Egyptian palace through which Moses and Aaron passed on their mission of protest to the Pharaoh Merenptah against the captivity of the Israelites, have been brought to the Museum of the University of Pennsylvania.

The portal will be reconstructed in its original form in a new wing of the museum, together with approximately 120 tons of additional material excavated by scientists of the university from the site of the ancient royal Egyptian city of Memphis.

The photograph above shows workmen with block and tackle placing a section of one of the massive pillars on its foundation in the museum. Carvings on the block represent the Pharaoh threatening the Israelites held captive by him, but finally permitted to leave Egypt. All known data point to the fact that Merenptah was the Pharaoh of the Exodus.

Each of the six stone pillars is 28 feet high and weighs five tons. The portal served as an archway in Merenptah's greatest palace. This palace was excavated at Memphis by Dr. Clarence S. Fisher, archeologist, after two years' work at a cost of thousands of dollars. The building was constructed of massive walls of sun-dried brick, with columns and door-frames of limestone. Within was a magnificent throne-room, which the Egyptian authorities have given to the university for reconstruction.

The palace contained a great open court 80 feet wide and 175 feet long, surrounded by a colonnade of 34 columns. At each end of the court were state apartments.

The six columns above mentioned formed a vestibule to the throne-room and supported the roof. Archeologists believe it was in this room that the Pharaoh declined to yield to the pleas of Moses and Aaron until finally a plague came, killing the firstborn in every Egyptian household. After the plague, he bade Moses and Aaron to lead the Israelites from Egypt.

Are There Twins in Your Family?

An expert answers questions so often asked about double birth, its causes and hazards—Why some twins look alike while others differ—Why one twin is usually more vigorous than the other—Heredity and its influences

By H. H. Newman, Ph.D.

Doctor Newman is professor of zoology and embryology in the University of Chicago, and is a distinguished authority on the mysteries of multiple birth. The facts and theories that he presents here are based on his 16 years' study of twins and twinning.—THE EDITOR.

FROM earliest times twins have been objects of unusual interest and curiosity, for there is real humor in the situation presented by the existence of two editions of the same person.

Only last week I met a vivacious woman, a duplicate twin so like her sister that even their most intimate friends could not tell them apart. Among other incidents of their interesting youth she told the following experience:

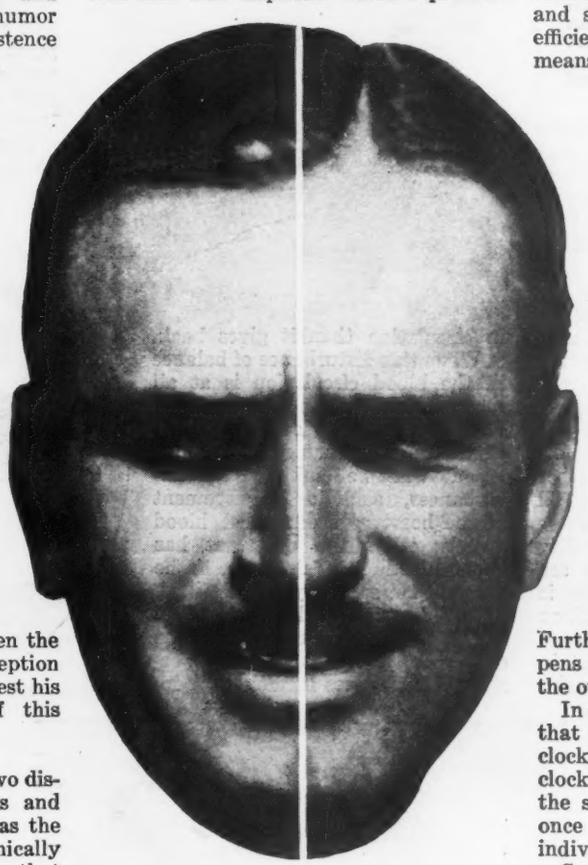
The sister at one time had a most assiduous suitor, who came so often and stayed so late that she was not getting enough sleep. So she bribed her twin sister to entertain the young man on alternate evenings. The scheme worked perfectly until, on one of the evenings when the substitute was on duty, the suitor began to make invidious comparisons between the sisters, saying that he did not see how any one could ever think they were alike!

This was too much for the young lady to stand and she confessed the whole plot. Even then the youth refused to believe in the deception and accused her of teasing him to test his sincerity. The final outcome of this episode was not related.

IN HUMAN beings we recognize two distinct kinds of twins—duplicates and fraternals. Duplicate twins, such as the sisters I have mentioned, are technically known as *monozygotic*, which means that they are derived from one zygote or fertilized egg. Fraternal twins are known as *dizygotic*, for they come from two zygotes. Thus, fraternal twins are merely brothers and sisters who happen to be conceived and born simultaneously. Hence there is no reason to expect them to be more alike than are other brothers and sisters, except that they are of the same age and are likely to have more nearly identical experiences.

Duplicate twins, on the contrary, have every reason to be alike, for they are biologically far more closely related than ordinary brothers and sisters. They really are two editions of the same individual. They begin life as a single egg, which develops for some time like any other egg, but later, for reasons that will be discussed, the embryo divides in such a way that the part that would normally produce the right side of a single individual forms a separate complete individual, and that destined to produce the left side similarly produces a separate individual.

Thus it may be said without exaggeration that true duplicate twins represent a single person duplicated. The two are genetically as closely related as are the right and left halves of one's own body. No wonder, then, that it is sometimes necessary to resort to ribbons of different colors in order to tell them apart!



Compare the two sides of this face of Douglas Fairbanks by covering first one half, then the other, with a sheet of paper. You will notice that while the two halves are very similar, there are certain distinguishing marks, such as the depth of the scowl and the formation of the mouth and eyebrows. Apply the same test to your own face in the mirror.

This difference in the sides of the face of any individual, says Doctor Newman, explains why some twins, though really two editions of the same individual and thus very similar, do not look exactly alike

Statistical studies of the degrees of resemblance between identical twins and between the opposite sides of single individuals amply justify these statements. The coefficient of correlation in both cases is in excess of .9, which means that both are more than 90 per cent identical.

In striking contrast with this is the fact that fraternal twins, or ordinary brothers and sisters, have, in both cases, a coefficient of correlation of only .5, which means that they are but 50 per cent identical.

A STRANGE thing about twins is that quite commonly they are reverse or mirror-image duplicates of each other, and not exact duplicates. By this is meant that the right side of one twin is often more like the left side of the other twin than like his own left side. Thus, if some one-sided peculiarity occurs on the right side of one twin, it is likely to appear on the left side of the other twin.

Professor H. H. Wilder, of the Department of Zoology of Smith College, described a number of cases in which the finger-print pattern of a given finger on the left hand of one twin was the mirror image not of that of his own right hand, but that of the right hand of the other twin. Furthermore, it not uncommonly happens that one twin is right-handed and the other left-handed.

In not a few cases it has been observed that the whirl of hair at the crown goes clockwise in one twin and counter-clockwise in the other. This is one of the surest evidences that the two were once right and left sides of a single individual.

Sometimes it has happened that twins, taken at first glance to be duplicates, prove to be much less alike than one would expect. Are these to be classed as fraternal twins because they do not fulfill our expectations as to resemblance?

Let us examine a parallel case. I look at my own face in a mirror and note that the two eyes are, in some respects, quite unlike. My two hands, especially in the details of the finger-prints, are very different. The shoe clerk tells me that one of my feet is about half a size larger than the other. My tailor finds difficulty in fitting me because one shoulder is broader and higher than the other.

Look yourself over and see how different your two halves, which are un-

"Alike as two peas"—Elsie and Ethel Howe, of Boston, Mass., are duplicates who have survived the hazards of twinning and are equally normal, healthy, and vigorous. Could you tell one from the other? Two younger brothers and a sister are triplets!

questionably of monozygotic origin, really are. Why should you expect, then, that two halves of a former individual that are now separate would be any more alike than two halves that have remained together as parts of a single individual?

THERE are, to be sure, many individuals in whom the two sides are remarkably alike. Parallelling this condition of approximate identity are the instances of extremely close resemblance between twins. From the biological point of view the two situations are essentially the same.

The life of twins before birth, whether they be monozygotic or dizygotic, is full of hazards. Statistics show that there is a high percentage of prenatal mortality in twin pregnancies. The reasons are not far to seek. The human uterus is adapted for but one fetus at a time. When two fetuses come to occupy the space normally occupied by one, there is certain to be crowding and keen competition for the available supply of nourishment. It is partly on this account that twins, at birth, are commonly much smaller than single offspring and are not as well nourished.

There is a popular impression that one twin usually is stronger and more vigorous than the other. Almost every parent of duplicate twins will tell you that one of them seems to be the dominant member of the combination, to be noticeably the leader in most enterprises, to be a little more vigorous and healthy. In some cases the difference in this respect appears to be striking. As is not uncommonly the case, popular impressions have a sound scientific basis.

Duplicate twins always have but one placenta—the nutritive organ connecting the fetus with the mother—between them, and there is always a keen contest between the twin fetuses for a share of this common organ. The result is that the placental blood vessels of the two, starting in at opposite sides of the disk-like placenta, meet at the center and struggle for the neutral area.

In the process of settling the dispute, it nearly always happens that blood vessels of the two individuals become united and the blood supplies of the two become intimately mingled. This would do no harm except for the fact that the give and take is likely to be more or less uneven. One may receive more blood

in circulation than it gives back.

When this disturbance of balance in the blood circulation is at all marked, one or both twins are sure to be more or less seriously damaged. The one that gets too much blood will be subject to disturbances, such as enlargement of the heart and distended blood vessels; while the one that has been robbed of its fair share, if the supply is seriously diminished, suffers from partial or complete atrophy of the heart, diminution of the blood vessels and other serious disturbances incidental to individuals with an insufficiency of blood.

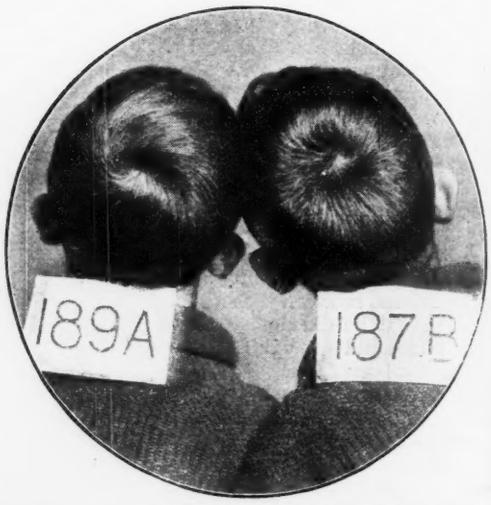
Even a slight imbalance might readily be sufficient to cause a noticeable difference between the twins in their relative vigor or general vitality. Twins, both of which are equally normal, healthy, and vigorous, may consider themselves unusually fortunate to have survived the hazards incidental to twinning without any untoward accidents.

What causes twins?

IN THE first place, it should be said that the tendency to produce twins, of both kinds, is hereditary and seems to be transmitted as often through the male line as through the female. What is inherited in the case of fraternal twinning appears to be merely a tendency for the two ovaries to become active at the same time instead of alternating in activities, as is the usual condition. The result is that at a given time each ovary produces a ripe egg and both become fertilized at the same time, thus producing two embryos.

This seems intelligible enough, but the explanation of duplicate twinning is not so easy. What we are reasonably sure of is that this type of twinning is the result of an early interruption in development, probably a failure for some days or weeks of the young embryo to attain a proper nutritive relation with the maternal tissues.

During this quiet period cooperation between the various parts of the embryo seems to be retarded and there is a tendency for parts of the body to become independent. In this way the two sides cease to act as though they were integral parts of a single individual; each becomes independent. The result is that when normal nutritive relations are finally attained, the two half embryos develop independently and give rise to two separate individuals.



Each of these duplicate twins shows evidence of being the reverse, or mirror image of the other. Thus, on the twin at the left, the whirl of hair on the crown runs clockwise; on the twin at the right it runs counter-clockwise. This, says Doctor Newman, is one of the surest evidences that the two once were the right and left sides of one person

Typical fraternal twins. They are no more alike than any other brother and sister, except that they happen to have been conceived and born simultaneously, and thus are likely to have more identical experiences throughout their lives. The boy has fair hair and blue eyes and is near-sighted, while the girl has brown eyes, dark hair, and good eyesight

"WHAT radio set shall I buy?" In next month's issue an expert will answer this question for you, offering you impartial advice on the set that will give best results in your particular locality.

Do You Sleep Too Much?

Six hours a night should be enough if you learn the right way to woo deep and restful slumber—Practical hints by a disinguished authority on how to increase your waking hours and so improve your health, happiness and efficiency

By Donald A. Laird, Ph.D.

THE one piece of advice that you probably have heard most often is —"Get plenty of sleep!"

Your parents undoubtedly began telling you that—and enforcing their wishes —when you were a child. Later you heard it from your family doctor, from your teachers, from your employers, your friends—in fact, from almost everybody who claimed to have your interests at heart. Eminent men when interviewed are fond of including some variation of the "early to bed, early to rise" adage as part of the recipe for success.

The implication in this familiar admonition, and the impression of the sleep question that you probably have retained from childhood, is that to try to get along with less than eight or nine hours' sleep a day is only a little less harmful from a hygienic standpoint than a systematic course of poisoning would be; that to sleep the clock around every night is about the surest way there is of becoming "healthy, wealthy and wise," and, I suppose, happy.

Of course, there are the Edisons, the Napoleons, the Humboldts, and the other great men, past and present, who accomplished most extraordinary things on only three or four hours' sleep a night. Probably you assumed that, being exceptional in so many other particulars, these men probably were exceptional in their sleep requirements as well.

AS IT happens, however, recent scientific investigation shows quite definately that the time-honored idea that it is wise to get a great deal of sleep has scant basis in fact; that, as a matter of fact, many people probably get too much sleep and that too much sleep may be harmful, just as too much food is. It shows, too, that, like food, the value of sleep to the body depends not on quantity but quality; that, though sleep may seem to be the most natural thing you do, there is an art of sleeping you can learn.

The famous men who slept little undoubtedly had mastered this art and had learned how to extract from a few hours of good, *sound* sleep more physical benefit than many people obtained from a full night of fitful, wakeful, light slumber.

Science shows, too, that there are good and bad times for sleeping; that the way you lie in bed has great bearing on the quality of sleep you enjoy; that by cultivating proper habits of sleep and surrounding yourself with conditions conducive to good sleep, you probably can reduce your sleeping time to six hours and yet awake refreshed, invigorated, and with no trace of the tired feeling that now may make rising in the morning so much of a task.

Undoubtedly you understand the purpose and general nature of sleep. Every living thing seems to sleep. Plants grow by rhythms—alternate periods of rest and activity—so do even the lowest forms of animal life. The single-cell amoeba pauses to rest. Mollusks have periods of inactivity during which they sink deeper into the mud.

YOUR sleep, though, is highly complicated. During sleep your pulse beats more slowly and more feebly than when you are awake. In fact, after you are asleep a few hours, it is virtually impossible for any one to detect your pulse with the fingers. Special apparatus must be used by scientists to take pulse records of persons who are serving as subjects in sleep investigations.

Also, when you sleep, the flow of blood to your brain decreases markedly. Science can thank a Parisian beggar for its first knowledge of this fact. This man was injured in a street accident, and portions of his skull were broken away, leaving the brain exposed. Through this "window" scientists in the hospital were able to watch the blood stream ebb and flow as he slept and awoke.

Upon the decrease of the blood flow to the brain during sleep depend such familiar methods of wooing reluctant sleep as eating a little, or placing a hot water bag on the feet. In either case the stimulation of the blood flow elsewhere in the body tends to draw the blood away from the brain; hence, tends to produce sleep.

If you find it hard to get out of bed in the morning, it is because you have not learned how to sleep. The "tired feeling" that makes arising at the call of the alarm clock so difficult would not disappear, as you imagine, were you able to disregard its summons, for the deep, restful sleep—the real restoring sleep that repairs weariness of body and mind—comes during the first hour or two after you go to bed. It is then that your muscles are

(Continued on page 145)

Do You Hate to Get Up in the Morning?

IF SO, it's because you haven't learned how to sleep, declares Doctor Laird as the result of his researches as professor of psychology at Colgate University.

"It isn't how ***much*** sleep you get that counts," he says; "it's the ***kind*** of sleep.

"You can coax deep, restful sleep by relaxing every muscle of your body—even your ear muscles. The way to relax is to sleep partly on your side and partly on your stomach.

"Take a noon-day nap, if you can. You will find yourself able to cut three or four hours at least from your night's sleep and still be stronger and more efficient mentally and physically."

If you teach yourself to sleep deeply, you will find that six hours is enough for you, Doctor Laird's experiments show. To cut down your sleeping time, stay up until a later hour and rise at your usual time

The Most Accurate Man in America

Slicing an inch into ten thousand parts was too crude and clumsy for Maj. William E. Hoke—A dramatic story of inventive genius that gave to industry new standards of measurement for quantity production

By Norman C. McLoud

A FEW split seconds—3¼, to be precise—served to show me why Maj. William E. Hoke is known to his friends as "Old Precision," and to a larger circle as "the Most Accurate Man in America."

I had asked him for the exact time—stressing the "exact." To furnish an answer fitting the specifications he swiftly consulted three watches, one on his left wrist and two from pockets.

"Twelve fifty-six and three-eighths," he replied with the comfortable assurance of one who knows whereof he speaks. "I checked up with Arlington at twelve o'clock."

As if a bare statement might be construed to lack something of precision, this master of accuracy flashed his radio log. An entry of the day showed the receipt of the Arlington time signal at noon, with this notation:

"Watch 2⅛ seconds slow. Touched regulator one quarter turn and set minute and second hands."

Time entries appeared on the log twice a day, with precise regularity, forming a complete diary of the watch, its performance and all adjustments.

That is Hoke. Accuracy is his passion. It makes him a tireless critic of things as they are. Sometimes he is called a grouch because of his habit of criticising. When you know him, though, his criticisms become merely a part of his struggle for accuracy. His three watches symbolize this struggle; his radio log gives it written expression.

It was this passion for accuracy that enabled Hoke to give the world a new standard of refinement in measuring length. Slicing an inch into 10,000 parts appealed to him as crude and clumsy for mechanics and science. Hoke wanted something finer—something that would enable the world to deal in fractions expressed in light rays.

The task he set for himself was dividing the standard inch into a million parts and making them workable. The Hoke precision gage was the result. Under the influence of his gage a millionth of an inch becomes a definite unit of measurement.

When Hoke talked of a millionth of an inch, my nearest grasp of the phrase was a gasp. As a step toward my education the Most Accurate Man abruptly snatched a hair—one of my own.

"It would take 1000 fine hairs, ranged side by side, to cover a standard inch," he told me. "You have less than half an inch left on your entire head. Suppose you took this single hair and split it lengthwise. Starting with a single filament having a diameter of one-thousandth of an inch, if you should cut it into one thousand strips, each strip would represent a millionth of an inch; a million of those strips would be needed to cover an inch of the surface of my desk here. The ordinary 'splitting of a hair' doesn't mean much in comparison."

EXACT measurement of each of the million strips has been made possible by light rays and the Hoke gage. The accuracy thus attained has been revolutionary. Some studious observers even insist that the millionth of an inch won the World War, which is a story in itself.

"When the war came, accuracy was a vital problem," Hoke told me. "The armies needed equipment in quantities never before conceived. This equipment had to be made in widely scattered factories. When assembled, the various parts had to fit. Each part had to be interchangeable with all other similar pieces. Everything had to be standardized."

This standard came about through the creation of the Hoke precision gages. These, briefly, are blocks of highly polished steel of precise thickness, which can be fitted together for any desired measurements. The method of making these blocks is simplicity itself.

"THIS is the way it works," he explained. "We put a man into a machine-shop with nothing but a standard yard or meter, and he can make 36 blocks of identical length. Because of highly polished faces, these blocks fit together exactly, without loss in the form of intervening spaces. This close adherence is accomplished by 'wringing' the blocks together—fitting them by means of a twisting motion that establishes perfect contact.

"In fact, the smooth blocks, fitted face to face with the wringing motion, become as a solid piece of steel, adhering so tightly that the combination will support a weight of a hundred pounds through tensile strength, without pulling apart! To separate them requires the twisting motion by which they were joined. This perfection of contact reduces the error of waste space to less than a millionth of an inch!

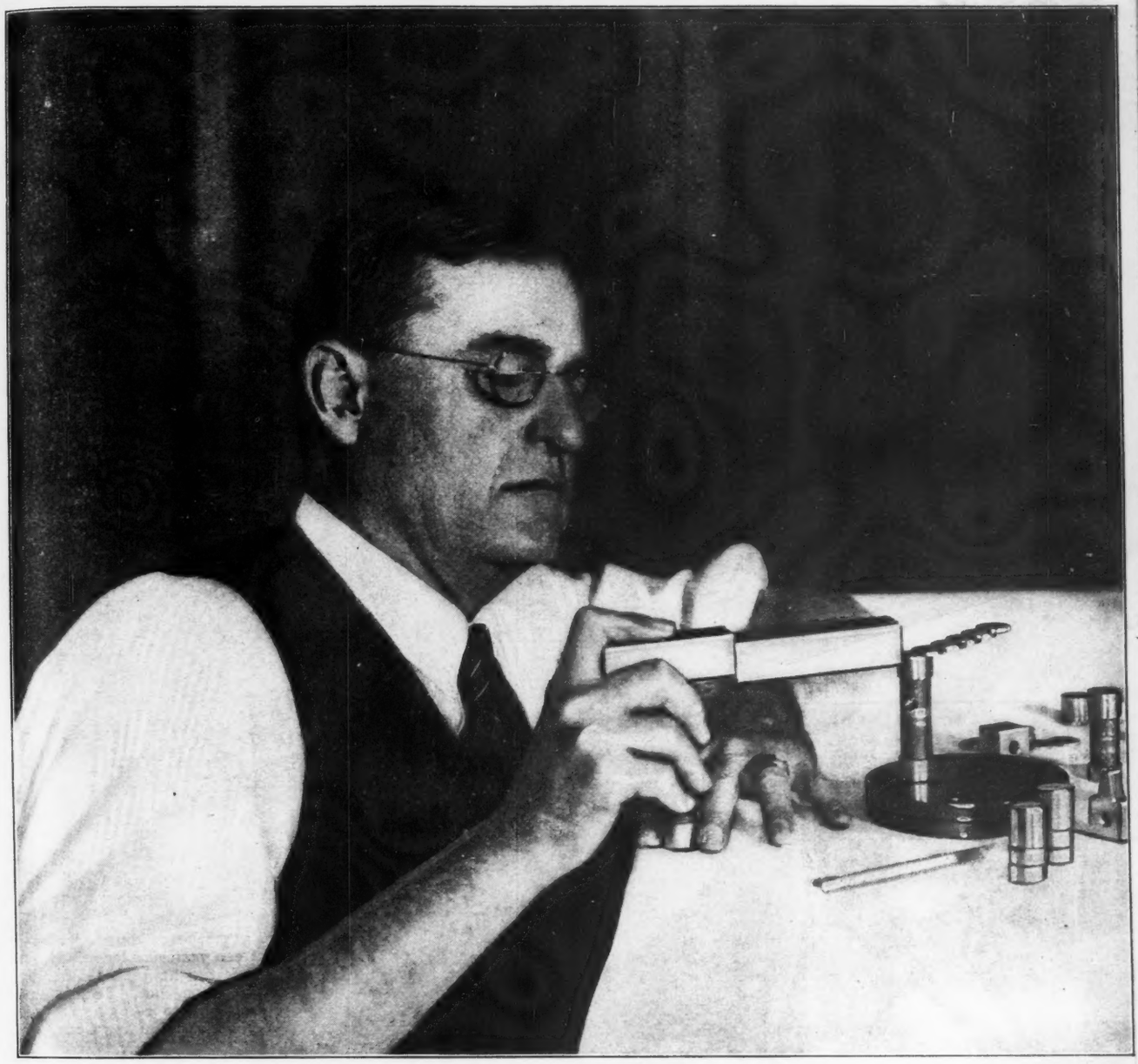
"When the workman has made his 36 blocks of identical length, he tests their thickness by stacking them up alongside his standard yardstick, using the wringing motion to produce perfect contact between blocks. Perhaps the comparison shows that the stack is too high. This indicates that his units are not the right size, so he planes off more from each of them.

Think of This the Next Time a Bee Stings You

"MAN still has a long journey before he reaches the precision of Nature," says Major Hoke. "Take the case of the fine needle, for instance. We consider its point exceedingly sharp, and so it is. But contrasted with the stinger of a bee it is not sharp at all.

"Highly magnified, the point of a needle appears as ragged as the broken stem of a telegraph pole. Under similar magnification the stinger of a bee is infinitely sharp; it approximates, I believe, the billionth of an inch, instead of the mere millionth with which we mortals are dealing.

"Man never has approximated such fineness."



Major William E. Hoke demonstrating the marvelous adhesion of his steel block gages when wrung together with a twisting motion. Several thin measuring gages adhering to each other rest on the column to which Major Hoke is pointing with two larger adhering blocks held in his right hand. A pull of 100 pounds would be required to separate the larger blocks when they have been wrung together closely, so perfect is their contact

"His method of making accurate comparison with the standard yard is simple, too. He may find, during his work, that the 36 pieces form a stack so closely identical with the length of the yardstick that the eye can see no difference. To make sure on this point he has only to take a knife straight-edge and lay it across the top surfaces of the stack and the stick. If there is a difference, the unaided eye can detect a crack of light 1/10,000 of an inch in thickness."

The comparison afforded by the use of the knife straight-edge enables the man in the shop to produce 36 blocks, each of them exactly an inch in length. Then come the subdivisions.

"To get smaller units, he merely divides an inch into blocks a tenth of an inch in thickness," Hoke told me, "so that he has everything necessary to produce units of any dimension running into three decimals.

"Suppose we take 12 standard inches and three standard tenths of an inch. This gives us a standard 12 3/10 inches in length. Then we make 100 identical blocks the combined length of which equals this standard. Each of these blocks necessarily is 123/1000 of an inch thick.

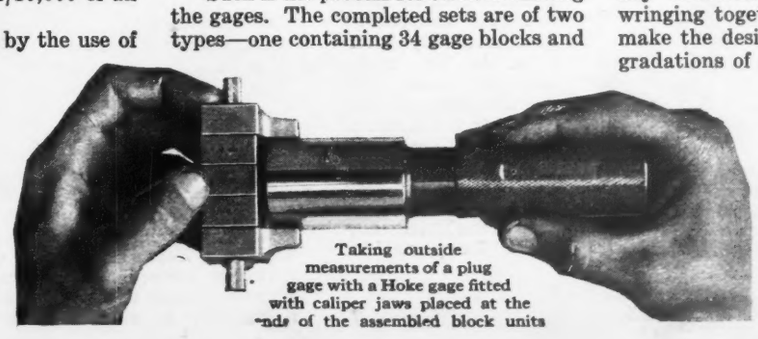
"Such is the process followed in making the gages. The completed sets are of two types—one containing 34 gage blocks and the other containing 81 gage blocks.

"The smaller blocks in each set are approximately one tenth of an inch in thickness, differing from each other on a scale measured by 1/10,000 of an inch.

"The next larger gages differ by a thousandth of an inch; larger sizes by tenths of an inch, and finally we have gages differing by a full inch. By fitting these blocks together, we can build up in any combination we may wish, simply wringing together the blocks required to make the desired total dimension. With gradations of a tenth of a thousandth of an inch, it is possible to create more than 100,000 gage sizes within 12 inches."

Application of the gages to every-day shop measurements is merely a matter of building up the blocks to the required lengths. The fine

(Continued on page 151)

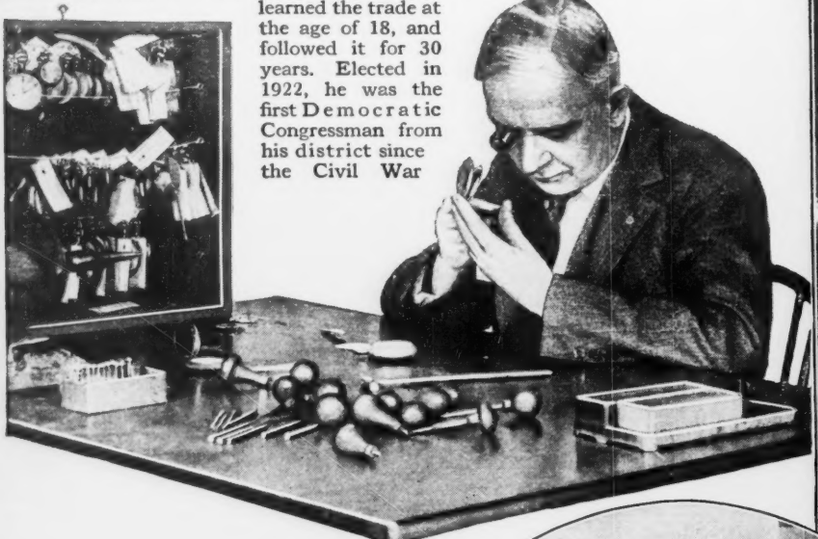


Taking outside measurements of a plug gage with a Hoke gage fitted with caliper jaws placed at the ends of the assembled block units

Skilled Mechanics in Congress

And What They Can Make and Mend Besides Laws

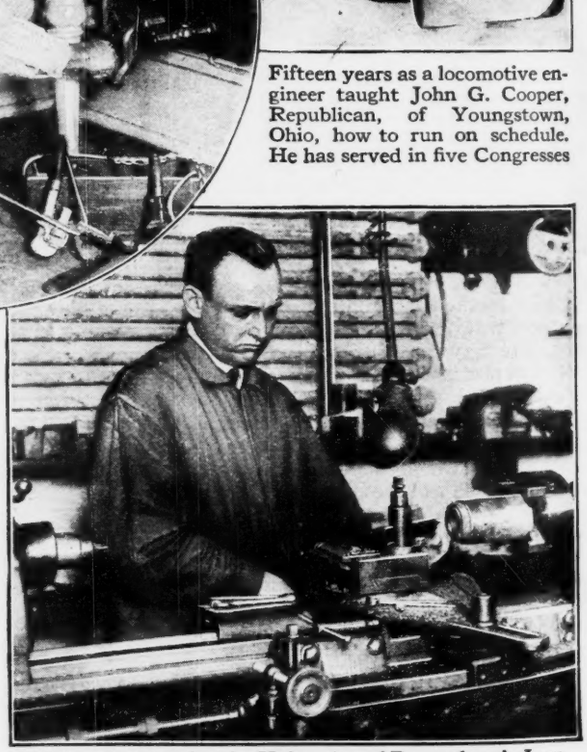
Congressman Frank C. Sites, Democrat, of Harrisburg, Pa., is a watchmaker and jeweler by trade. Educated in the public schools, he learned the trade at the age of 18, and followed it for 30 years. Elected in 1922, he was the first Democratic Congressman from his district since the Civil War



Fifteen years as a locomotive engineer taught John G. Cooper, Republican, of Youngstown, Ohio, how to run on schedule. He has served in five Congresses

John J. Casey, Democrat, of Wilkes-Barre, Pa., is one Congressman who knows how to find leaks and fix them. He began working when he was eight years old, first in the coal mines of Pennsylvania, and later as a plumber and steamfitter. He always has been actively interested in the trade-union movement, and was the first man to be elected to the House of Representatives on a straight labor ticket. During the World War he served as labor advisor to the Emergency Fleet Corporation

In making paper, as in making laws, Thaddeus C. Sweet manages to keep things stirring. This photograph shows him at work in the paper factory of which he is president. Besides being Republican Congressman from New York, he has been in the paper-manufacturing business ever since 1895



While preparing for the University of Pennsylvania Law School and a legal career, Congressman Everett Kent, Democrat from Bangor, Pa., worked for a considerable period as a machinist, constructing hoisting machinery. He was elected to the Sixty-Eighth Congress, winning a majority in all the three counties of his district

He Photographs the Invisible

The story of Philip O. Gravelle, whose astonishing skill with microscope and camera has opened new eyes for industry—The beautiful tongue of the fly—The comb on the spider's leg—What makes water look green—Why a dull razor blade "pulls"

By Fritz Blocki

HAVE you ever examined the tongue of a fly?

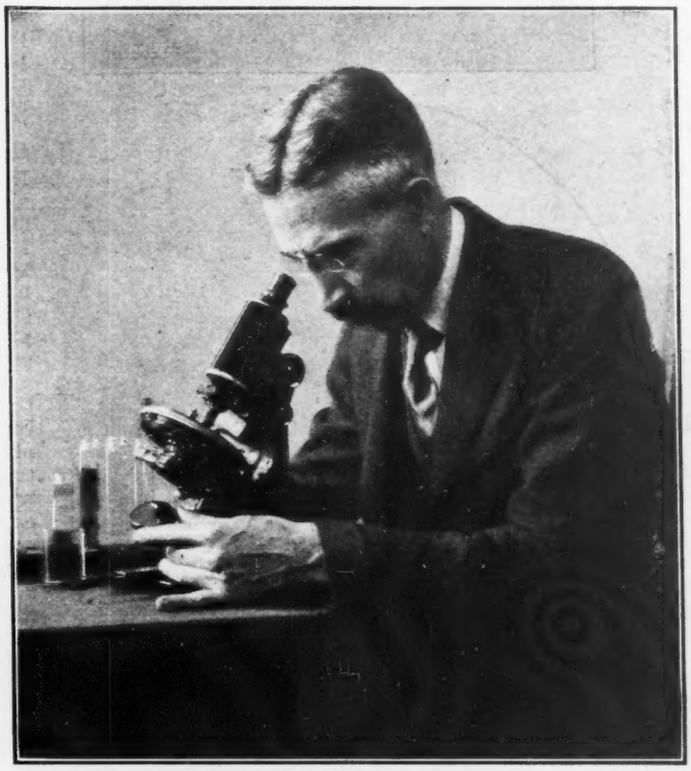
Did you know that the silky butterfly's wing is really covered with scales, or that the spines on strawberries are like big carpet tacks?

Perhaps it will be news to learn that the tiny foot of a spider carries two miniature pocket combs on its end and that a snail has a tongue which is a beautiful and complex succession of spines.

These are but a few of the everyday marvels seen by Philip O. Gravelle of South Orange, N. J., to whom a phonograph record looks like a succession of mountainous ridges, a safety razor blade like a jagged sheet of boiler plate, and microscopic organisms a few thousandths of an inch in size like fierce denizens of the jungle.

Mr. Gravelle is known officially as a photomicrographer. In simpler language, he sees and photographs the invisible world with a scientific sight nearly 2,000 times as powerful as the unaided eye, by means of a microscope and either a still or motion picture camera. If an ordinary ant actually were increased the number of times Mr. Gravelle can magnify it with the microscope it would become a frightful monster more than 10 feet tall, approaching the size of an elephant.

Mr. Gravelle's skill in photographing infinitesimally small objects has brought across the Atlantic for the first time one of the most recent of distinguished scientific awards—the Barnard Medal, presented to him by the London Photomicrographic Society. He won the distinction of being the first American to receive this honor over constestants entered from all over the world.



If you could look through the microscope with Philip O. Gravelle, you would discover an astonishing new world of tiny wonders. Mr. Gravelle's skill in revealing and photographing this invisible world with scientific eyes nearly 2000 times as powerful as human eyes, has won for him the highest honors in his field of science—the Barnard Medal awarded by the London Photomicrographic Society. This photograph shows him in his laboratory, examining the millions of minute living organisms in a single drop of water through the lens of a powerful microscope

THE science of photographing under the microscope has been practiced for some time in such fields as pathology, biology and botany; but now, largely through the efforts of Mr. Gravelle, its usefulness has extended to another purpose, that of furnishing an additional link between science and industry by solving mysteries and difficulties of manufacturing which could be solved in no other way.

To give an idea of the exacting scientific work involved, one of the eight requirements in the competition which resulted in Mr. Gravelle's winning the Barnard Medal called for photographing the hairs on the tip of the tongue of a fly, and enlarging 1500 times a species of a minute aquatic plant known as a diatom, which is so small that it cannot be seen by the naked eye.

By placing the motion picture camera behind a battery of optical instruments the life motions of minute organisms may be photographed and later shown on a screen—a vivid motion picture drama, magnified thousands of times.

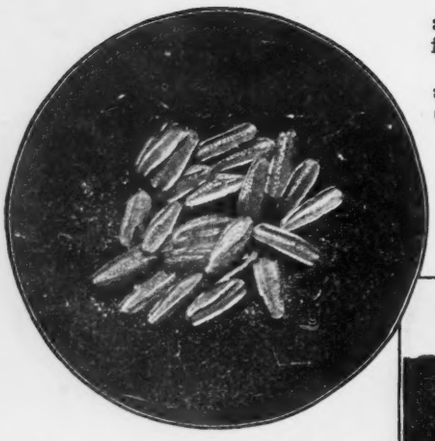
"The results of this work are closely linked with our daily lives," Mr. Gravelle told me. "The findings help to lead to a better and clearer understanding of many of nature's wonders. For instance, you often have seen the surface of a pretty woodland pool marred by a green scum. To you that means the water is stagnant, dead, and so you shun it. But do you know that actually it is teeming with life?

"The scum is not dead. It is made of countless millions of single living cells that form a spiral network of green bands, giving the substance its color. Patches of green on the bottom of the pool are beautiful microscopic plants. Specks on the water so small as to pass unnoticed are really beautiful plant designs in varied fantastic shapes. Other minute spots that would seem motionless if you could see them, really are moving forward and backward like miniature submarines, pushing aside debris much larger than themselves.

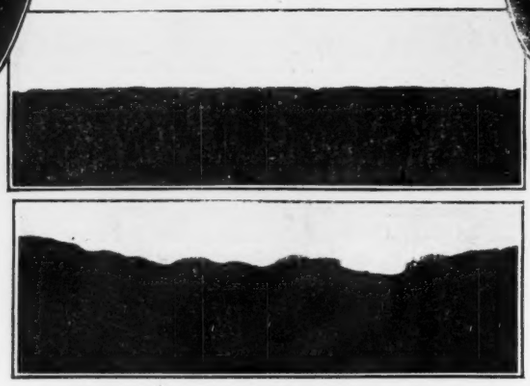
"IF you are out for a swim you pass on to a clear pool, one that lies limpid and green in the summer sun. The microscope shows that really you are swimming in a sea of animals, tiny globules which are gracefully revolving and giving the water its greenish cast. The technical name of these creatures is volvox, and are what make the pool look green. The motion is due to tiny hairs called cilia.

"If you pick up a submerged leaf and look at it closely you may find a few jelly-like specks on its surface. Photomicrography reveals these to be a variety of animals known as rotifers. Motion pictures of one of the specks show that actually it is a whole colony connected with a common center by threads radiating like the spokes of a wheel. The colonies are continually in motion, folding and unfolding like the petals of a flower. Their cilia vibrate rapidly, agitating the water and causing food particles to stream toward the minute mouth of each rotifer and then to still smaller jaws.

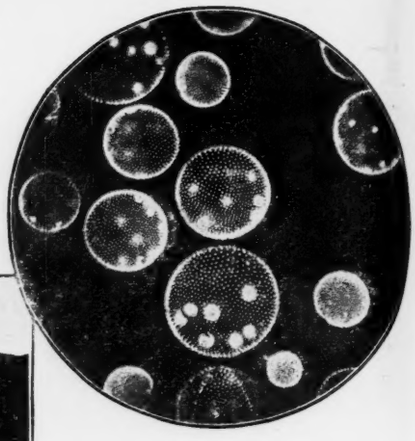
"A fly's tongue, so small that it can hardly be seen without a lens, makes a beautiful photograph, with dainty curved lines extending in loops from each side like a fine etching. A wasp's wing is seen



To our unaided eyes this group of fly's eggs would appear as a speck so small as to be almost invisible. Highly magnified, the speck is seen to include a score or more eggs in a cluster



The reason your razor blade pulls when dull is explained by the photomicrographs below. The upper one shows the edge of an unused blade; the lower one reveals what frequent contact with a beard will do. Both are magnified 300 times



A group of volvox, the tiny globe-shaped creatures that make the water of a pool look green when millions of them revolve on its surface. They move by means of little hairs called cilia

to be two separate wings bound together by a very fine series of hooks."

Fascinating as are these unsuspected marvels which nature conceals beyond our vision, I learned that they are only part of the story. The other part has to do with its practical application in industry.

"Microscopic photographs of the invisible world have become an immense aid" he said, "for such purposes as choosing between proposed new manufacturing methods, and in detecting faulty construction.

"For example, I was called in by a manufacturer of razor blades who was puzzled by the statement of a competitor that shaving wore out a blade by turning over tiny edges at the cutting surface. By enlarging a new and a used blade 600 times, we found that repeated shaving with an unstropped blade nicked the edge, instead of turning it over.

"In another case a manufacturer of textiles wanted a measurement of the nap of some velvet. No instrument was fine enough to do this. The photomicrograph was called upon and not only measured these tiny threads but showed up conspicuously any of them that protruded the slightest fraction of an inch above the rest.

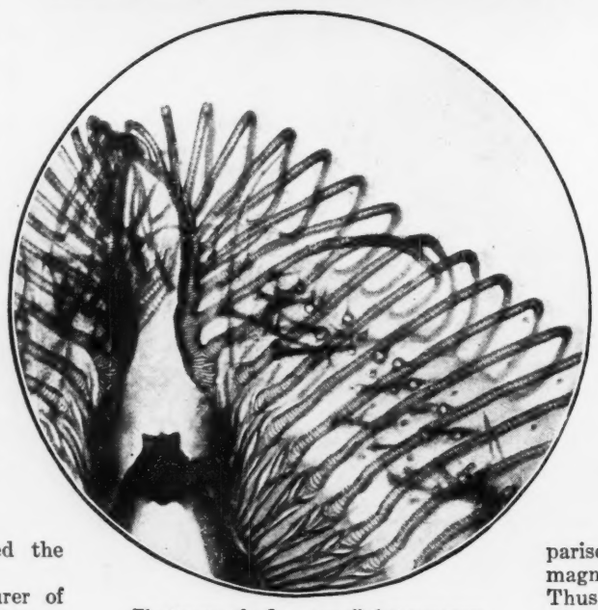
"My instruments revealed many valuable facts about phonograph records and needles. One maker could not find out why his records would not stand up under continued use. By magnifying cross sections of faulty records 60 times the photomicrograph discovered a thin wall about a thousandth of an inch thick at every fourth revolution. This broke down and caused defects in the records.

"The trouble was traced to a damaged screw thread in the master machine. Now the sapphire needle used in the original record is examined for perfection before being used. The photomicrograph will show beforehand just how it will rest in the grooves, and thus prevent defects.

"While the application of photomicrography is still in its infancy, its scope seems limitless. For example, the photomicrograph will prophesy the performance of an alloy by revealing its crystal structure. Extraordinary polishing and very high magnification are necessary to reveal the closely-knit crystals, so as to allow them to be photographed. The photomicrograph also will determine the covering quality of paints by measuring the fineness of their pigments, which in turn govern the oil absorption of the paint. The polishing or cutting powers of abrasives can be measured by ascertaining the exact microscopic size of the particles and sharpness of the grains.

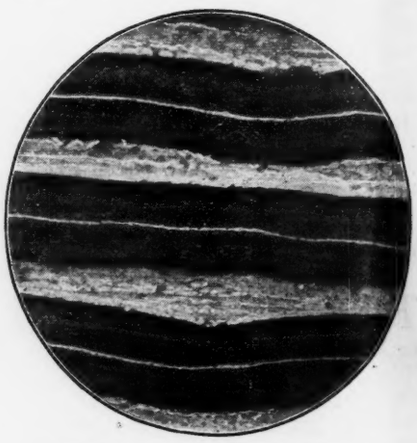
"In this connection a choice between two manufacturing processes was determined by a photomicrograph. A manufacturer of files was uncertain whether to finish his product with a sand blast finish or by the use of a soft abrasive. The fact that the sand blast gave the ridges of the file the sharpest cutting surfaces was shown by a microscopic comparison of samples of each process at a magnification of only 16 diameters. Thus by consulting the microscope the superiority of one process over another was predetermined."

So it is that Mr. Gravelle's skill with the microscope and the camera is opening new eyes for industry.

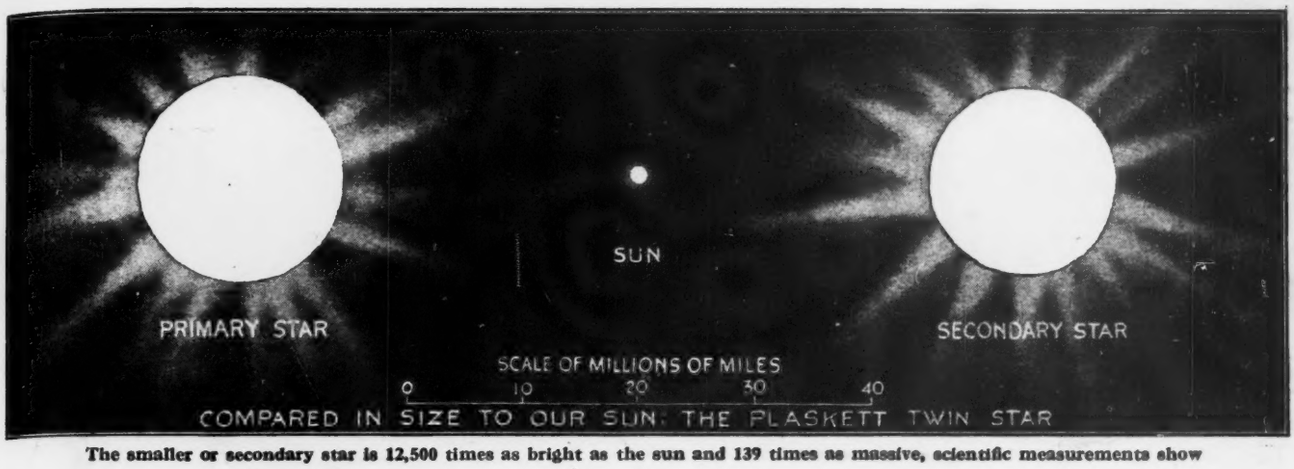


The tongue of a fly, so small that your eyes hardly could see it, is revealed by the microscope to be a beautiful work of nature, with delicately curved lines extending in loops from each side, as shown above

The tiny foot of a spider, when magnified about 45 times, is seen to be equipped with sharp-toothed combs that explain its astonishing ability to climb steep surfaces



A photograph of the lateral grooves on a phonograph record, magnified 70 times. The little furrows that ordinarily seem so close together, appear widely separated



The smaller or secondary star is 12,500 times as bright as the sun and 139 times as massive, scientific measurements show

New Wonders in Giant Twin Star

Strange Flaming Balls of Gas Twelve Times Hotter than Molten Iron

Discovered by Dr. J. S. Plaskett

TWO vast flaming balls of incandescent gas 12 times hotter than molten iron—the smaller ball 12,500 times as bright as the sun and 2000 times the diameter and 8,000,000,000 times the volume of our earth—hurtling about each other in a colossal ellipse of 173,000,000 miles every two weeks at the amazing speed of 128 and 153 miles a minute respectively!

To such a tremendous conception were the imaginations of astronomers summoned recently when the Dominion Astrophysical Observatory, Victoria, B. C., analyzed the light from B. D. 6° 1309, a star catalogued more than 60 years ago and visible to the keen, unaided eye.

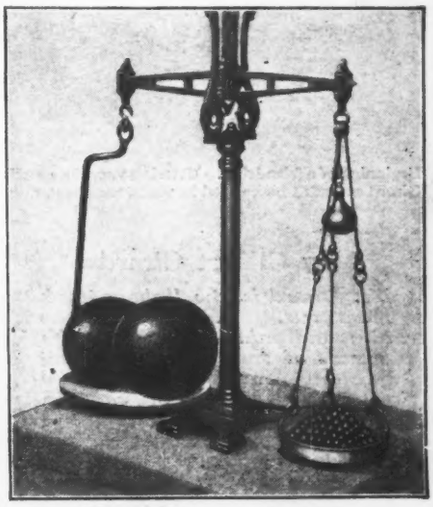
For the spectroscope—an instrument that breaks up starlight into the various colored lights that compose it—and mathematical analysis revealed that this barely perceptible gleam came from two stars, by long odds the brightest and most massive ever discovered.

By means of the great 72-inch reflector of the Dominion Observatory, the diameters of these great twin stars, as well as their distance apart, have been measured. Each has been weighed. Their physical properties, temperature, and brightness have been determined. It has been found that they are three times as hot as our sun, and that their distance from our earth is at least 52 million billion miles!

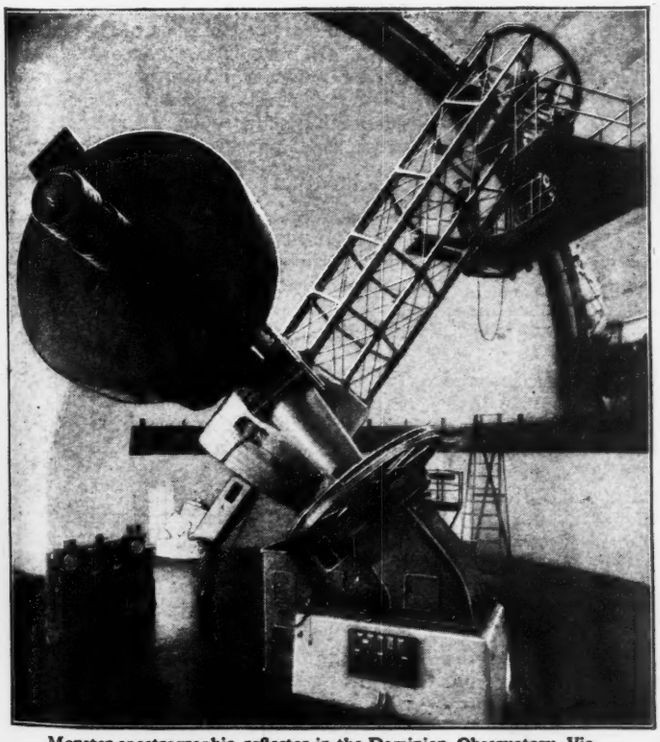
TEN thousand years ago, centuries before primitive man found his way upon the stage of history, the light that only yesterday was analyzed started racing to the earth at the terrific speed of 186,000 miles a second. While history dawned and while empires and civilizations waxed and waned, that light streaked tirelessly across the inconceivable immensity of interstellar space.

If this giant twin star were inhabited and possessed astronomers, today they would be studying light from our earth which started on its cosmic journey ages before the stones of Nineveh were laid.

Stupendous as are the figures that have been cited to describe these twin giants, probably they far understate the facts. For they are calculated, with scientific caution, on the theory that the orbit of the twin stars' vast swing is in the line of our sight. If such is not the case the figures would be much larger. As the bodies have not been observed to eclipse each other, probably their respective weights are at least 14 per cent greater than the figures mentioned, and their velocities at least five per cent greater.



The combined mass of the Plaskett twin stars is equal to 139 suns



Monster spectrographic reflector in the Dominion Observatory, Victoria, B. C., used in measuring and weighing the Plaskett twin stars

THE next largest twin star known is V. Puppis, determined at Harvard Observatory, with a combined mass 33 times that of the sun. The combined masses of the monster pair determined at the Victoria Observatory are 139 times that of the sun, at the lowest estimate.

It is not impossible that these stellar Titans no longer exist, except as a diffuse nebula, a great fire mist streaming across incredible millions of miles. For in bodies with such enormous masses the radiation or light pressure of the interior is nearly equal to the prodigious gravitational force that tends to contract them. So delicate is this balance that even a slight disturbance of it might release the prisoned energies within them in a mighty cataclysm, exploding them across the black vastness of cosmic space.

Why the Animals

Expert Tells How You Can

Beginning of a friendship. Uttering yapping sounds in imitation of a puppy, Mr. Girard extended his cupped hands to the chow, which came to look for the puppy

"In addressing monkeys or apes, friendly sounds must be accompanied by appropriate facial expressions," says Mr. Girard. This is how he appears while enjoying a friendly and mutually entertaining chat with a gorilla

By Gilbert Girard

Mr. Girard is the "phonograph menagerie." He supplies the bird and animal sounds for the records of many of the leading recording companies. He is the particular favorite of children all over the country, for he has made "bedtime records" of the best loved nursery stories and rhymes, and he makes the animals in these stories speak their own language.

He has made a serious study of the language and habits of these furred and feathered folk, and from his experience says any one with ordinary vocal powers can learn how to imitate them. In this article he tells just how you can emulate his remarkable powers of mimicry.

IF YOU are fond of birds and animals, you can learn to talk to them in their own language. Friendliness and patience are all you need to make you an imitator of animal sounds, if you follow the scientific methods of the professional mimics who have made these sounds their special study.

The shy but friendly robin in your back yard or that cheery busybody, the squirrel in the park, will respond to your comradely call and soon you will have a circle of furred and feathered friends.

The first step in learning mimicry is to watch the bird or animal as it gives its call. The position of the head usually will tell you whether the sound is made with a contracted or expanded throat. The head up and the neck stretched indicate an open throat and sound produced with exhalation.

Animals whose language is guttural almost invariably speak with lowered head. This means that to imitate their sounds you will contract your throat and practise your imitation with an inhalation. The lion's roar is an exception, because he gets his guttural sound from the stomach and diaphragm as he exhales. After you have an animal's "formula," it is only a matter of practice for you to be able to answer him correctly. Do not be afraid of the sound of your own voice.

The mechanism of the throat and mouth with which it is possible to imitate the widely varied sounds of animals and birds

THE animal usually is puzzled by the sound of his own kind coming from the throat of a man. Your dog, for example, will be frightened by this power of yours to make sounds that indicate the presence of another dog when none is in sight. But an ingratiating whine, such as he uses to win your attention, will reassure him and he will be overjoyed.

The popular conception of the sound of the dog's bark is a "bowwow." As a matter of fact, what the dog really says is "wow." To imitate the small dog's "wow" successfully, first open your throat passages, then pucker your mouth as in a pout. Now, while your mouth is in this position, say "ou," as in "you," and as you do so snap your mouth open, saying "wow" until your mouth is wide open. In making the sound your tongue should lie flat on the bottom of your mouth, and your voice should be pitched at a high head tone.

IN IMITATING a large dog, the procedure is the same, except that you should sound a deep bass tone—a chest tone rather than a head tone. In this case the "ou" is a long, deep growl from the throat, like a snore.

A study of the habits of animals will give you an understanding of the meaning of their various cries that will repay you generously. You have heard squirrels whistle many times, yet if you imitate that call while you are trying to coax a little fellow to take your offering of food, he will make for the treetops. For that whistle is the squirrel's warning call.

To invite a squirrel or chipmunk to luncheon in language he will understand,

Understand Me

Learn Secrets of Mimicry

The author, serving refreshments, discusses prohibition with a camel in the zoo. "An offer of food," he says, "is the token of friendship all animals and birds readily understand. Feed them while you coax them to speak"

To invite a squirrel or chipmunk to luncheon in language he will understand, make his own deep clucking sound by snapping the tongue against the back of the palate, as you inhale. Then smack the lips rapidly. Repeat this persistently without changing your position

make his own deep clucking sound by snapping the tongue against the back of the palate as you inhale. Then smack the lips rapidly. Repeat this persistently without moving and he probably will grow bold enough to take a nut out of your hand.

THE purr is a friendly password to all the cat species, from Tabby to the wildcat and tiger. This sound, varying in volume with the size of the animal, is simply inhalation and exhalation with a rattling of the palate that is little more than a subdued snore. Be sure that you do not let the sound come from the throat in rehearsing the purr, for then your amicable greeting might be confused with a snarl.

It is popularly supposed that a cat says only "meow." But listen to the rather staccato sound the cat makes in greeting you when you enter the house. Stroke it a little and tell it just what a nice kitty it is. Immediately, you will observe a difference in its "meow" when it tries to engage in conversation with you.

Of all animals the cat is one of the easiest to imitate. The sound "me-ow" begins with a long drawn out "me" with the throat contracted. For the "ow" the throat is opened and the sound is thrown through the nasal passages, producing a head tone. When the cat is pleased, the "me-ow" is very soft. When it is hurt, the sound is loud and long drawn, with a heavy, open tone for the "ow."

This cat was very much afraid of the camera. Only by making a soothing purr was Mr. Girard able to gain her confidence

To imitate the spitting of the cat, first make a hissing, spitting sound by blowing through closed lips. Then, placing your tongue in the middle of your mouth and contracting the left cheek, force the air between your tongue and your right cheek at the back of your mouth. Let the sound escape between your teeth and cheek, producing a squeaking, squawking sound. Finally, if you tap rapidly on the side of your mouth and cheek with your hand, breaking in now and then with the spitting sound, you will have a realistic cat fight.

An offer of food is the token of friendship all animals and birds understand. Feed them while you coax them to speak and they will lose their natural distrust. The curiosity of birds will draw them nearer and nearer to you. But, if you are carrying a walking stick, an umbrella, or anything else that may remotely resemble a gun, birds will remain at a safe distance and let you keep the food.

ALWAYS bear in mind that animals are subject to headaches, toothaches, dyspepsia and corns just as man is, and are affected with the same grouchy moods that accompany these ailments in human beings. Because an animal is crabbed and uncommunicative today does not justify us in assuming that he has a naturally mean disposition. Leave him alone and then try to make friends with him another day; you may find him a genial, responsive creature, after all.

Imitating the sheep is good training for the beginner. Let the tongue relax at the bottom of the mouth. Then say "ba-a-a," making it a throaty sound with exhalation and tapping the Adam's apple gently.

A somewhat similar sound is the cry of a calf. This plea for its mother's attention will sound to your ears like "um-bur." The first syllable is a nasal sound made with closed mouth. For the second, the tongue and throat take the same position you used for the sheep's "ba-a." If you think a cow has no powers of deduction, give this imitation of a calf's distress signal and then bark like a dog giving chase. You will see every cow within hearing ready to charge a stone fence.

AMONG the animals that make their calls with contracted throats are the donkey and his cousin, the zebra. To mimic the zebra, contract the throat and vocal chords, sucking in the air to make a loud squeaking whistle. Repeat this about five times, not too rapidly, then give the sound of "haw" as you exhale.

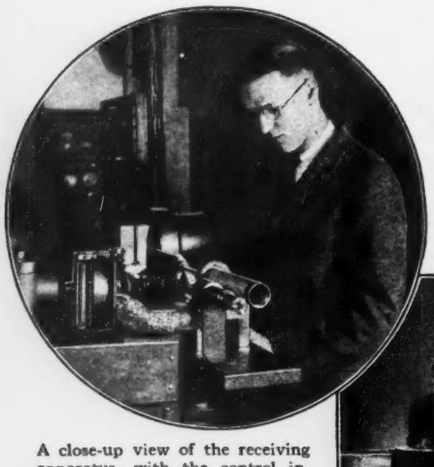
(*Continued on page 150*)

New Uses for Photo-Telegraphy

Police Send Finger-Prints of Hunted Criminals by Wire

By Newton Burke

WHEN engineers of the American Telephone & Telegraph Company and the Western Electric Company recently perfected a practical, commercial method of transmitting pictures by wire, the process was acclaimed mostly for its value in the dissemination of news pictures. It was pointed out that



A close-up view of the receiving apparatus, with the control instruments in the background

newspapers, when the picture-transmitting stations were generally installed, need no longer wait for trains and ships to bring photographs of far-away happenings. The pictures would be available for publication almost as soon as reports of the events that they illustrated could be transmitted by means of the telegraph.

A few weeks ago, however, another and more dramatic use was found for the new photo-transmitting process. It was demonstrated to be one of the most useful weapons ever put into the hands of the police for their war against the criminal.

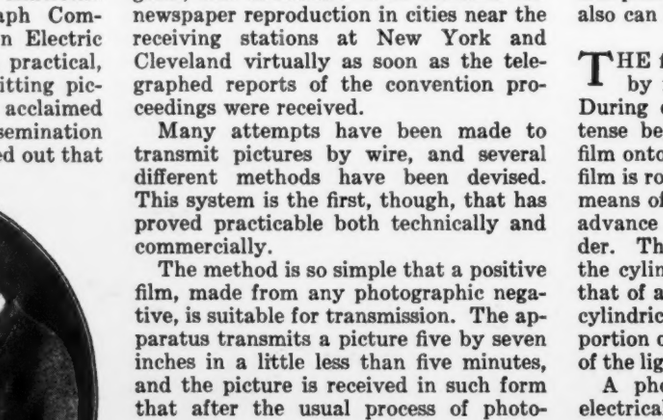
With the aid of telegraphed pictures, when a countrywide search is instituted for a criminal, the police of distant cities need not depend on a telegraphed "description" of the fugitive. They can have a photograph of him immediately. More, they can have his finger-prints, specimens of his handwriting, or any other sort of identifying material that can be photographed

AS A test of the value of the photo-transmitting process in tracking criminals, the New York police selected a finger-print from the files at Police Headquarters, and telegraphed a photograph of it to Chicago. The transmission required about four minutes, and scarcely was it completed when the Chicago police telegraphed back an identification of the man.

Insofar as its first purpose—the transmission of news pictures—is concerned, the new process proved itself beyond question during the recent Republican and Democratic National Conventions at Cleveland and New York respectively. Photographs of convention scenes, delegates, and candidates were available for newspaper reproduction in cities near the receiving stations at New York and Cleveland virtually as soon as the telegraphed reports of the convention proceedings were received.

Many attempts have been made to transmit pictures by wire, and several different methods have been devised. This system is the first, though, that has proved practicable both technically and commercially.

The method is so simple that a positive film, made from any photographic negative, is suitable for transmission. The apparatus transmits a picture five by seven inches in a little less than five minutes, and the picture is received in such form that after the usual process of photographic development, it is ready for reproduction. Line drawings, handwriting, and printing, provided it is not too small, also can be transmitted.

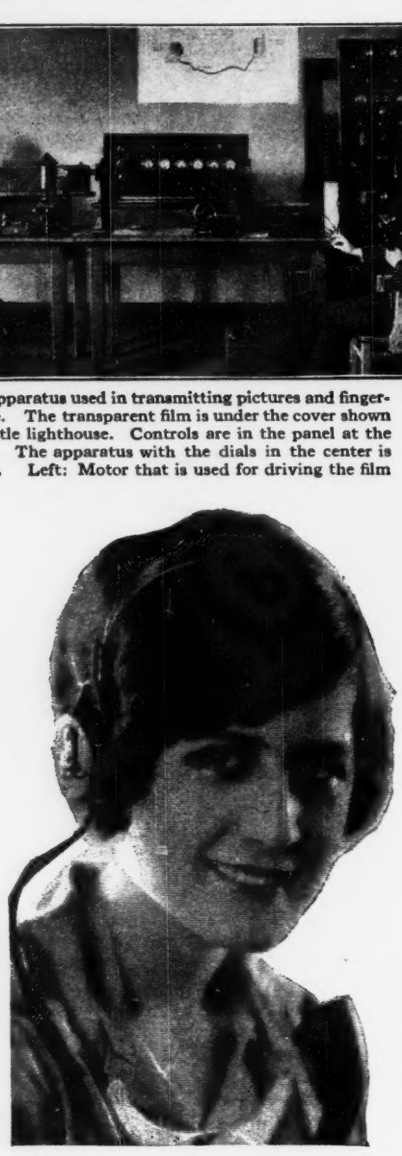


The sending apparatus used in transmitting pictures and finger-prints by wire. The transparent film is under the cover shown behind the little lighthouse. Controls are in the panel at the extreme right. The apparatus with the dials in the center is the amplifier. Left: Motor that is used for driving the film

THE film is inserted in the transmitter by rolling it up in cylindrical form. During operation, a very small and intense beam of light shines through the film onto a photoelectric cell within. The film is rotated at a uniform speed, and by means of a screw mechanism is caused to advance parallel to the axis of the cylinder. The motion of the light relative to the cylinder consequently is the same as that of a phonograph needle relative to a cylindrical record. Thus, each minute portion of the picture affects the intensity of the light reaching the photoelectric cell.

A photoelectric cell is a device the electrical conductivity of which varies according to the intensity of light directed upon it. In the photographic transmission process, the variation in the amount of light striking the sensitive surface of the cell, caused by the lights and shadows of the picture, gives rise to a current. Through the agency of a vacuum-tube amplifier and modulator, this current controls the telephone line current.

The most dramatic use to which the photo-transmitting apparatus has been put came when this finger-print of a criminal was sent by the New York police over the wire to Chicago. The transmission took four minutes, and two minutes later the Chicago police telegraphed back a correct identification



This picture of a young American Telephone & Telegraph Co. operator, sent from Cleveland to New York, illustrates with what fidelity a transmitted photograph can be reproduced

At the receiving end an unexposed photographic film is rotated under a beam of light in a manner similar to that at the transmitting end. Both films rotate at exactly the same speed, and, by means of a new device known as a "light valve," the impulses starting from the photoelectric cell at the transmitter, control the amount of light reaching the film at the receiver.

The system has been demonstrated to be applicable to radio when atmospheric conditions are such that steadiness of transmission and freedom from interference can be assured.

Keeping Abreast of Science

What the Newest Discoveries Are Worth to You

ENGINEERING science is the modern covered wagon, opening up trails to new countries, pushing the frontiers of civilization to new limits, fitting for habitation untrodden lands where Nature stands, a stubborn sentinel, repelling the advance of those who would wrest from her the territory where she always has reigned in complete supremacy.

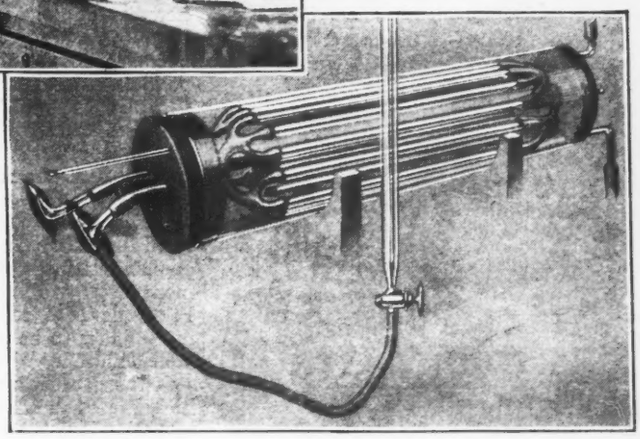
The amazing accomplishments by this present-day pioneer are typified in the work of the United States Reclamation Service, the efforts of which are dramatically set forth in a survey recently completed by a committee appointed by Secretary of the Interior Work.

In 20 years, working in 15 Western states, with Washington, Arizona, Texas, and Nebraska at the remote ends, the service has made habitable and fertile more than 1,200,000 acres of desert lands, that now yield an annual crop value of between $50,000,000 and $75,000,000.

It has supplied home sites for more than half a million people. Only Maine, of all the New England states, can report a larger number of farms than those contained on these once arid lands. Flourishing communities, with all the activities of the typical American town, have sprung up in the sections that irrigation has reclaimed. More than 90 per cent of the settlers are native-born Americans; hardy, venturesome souls of the type that crossed the plains in the days of '49 and won the West to civilization.

It is interesting that all of this work has been accomplished at no expense to the American taxpayer. The initial funds of the Reclamation Service were supplied by the sale of public lands, while the products of the reclaimed lands and contributions from the states benefited have supported the service through the years.

Dr. John J. Abel of Johns Hopkins University, who has invented the mechanical kidney, a wonderful instrument that will take the blood out of your body, clear it of impurities, and return it to your veins again. This amazing new weapon of medical science is shown at the right



A Mechanical Kidney

REMOVING every drop of blood from a human body, cleansing it of impurities and then returning it to the circulation may seem like an impossibility, yet that is exactly what German scientists purpose to do, utilizing the "artificial kidney," an amazing device invented by Dr. John J. Abel, professor of pharmacology at Johns Hopkins University.

The "artificial kidney" was developed by Doctor Abel to be used in treating victims of bichloride-of-mercury poisoning, scarlet fever, acute nephritis, and similar toxic states. Its name is derived from the fact that it stimulates the action of the natural kidneys. Doctor Abel has used it successfully on animals, but if the German scientists carry out their announced intentions, their experiments will mark the first use of the device on human beings.

The artificial kidney may be described as a sort of filter. One end is attached outside the body to an artery, and another connection is made to a vein. Thus the blood passes through, and the impurities are strained out by tubes of a substance called "celliodin," which, however, does not remove the vital corpuscles and proteins. An extract called "hirudin," obtained from Hungarian leeches, prevents the blood from clotting as it passes through.

Doctor Abel was prevented from continuing his early experiments with the apparatus when the war made it impossible to obtain hirudin. If the artificial kidney is successfully used on human patients, it is likely to prove one of the most successful weapons ever given to medical science for treatment of disease.

Rays from the Animals?

LIVING plants and animals are radioactive, sending forth rays like radium, according to a report made recently by Albert Nodon, French scientist.

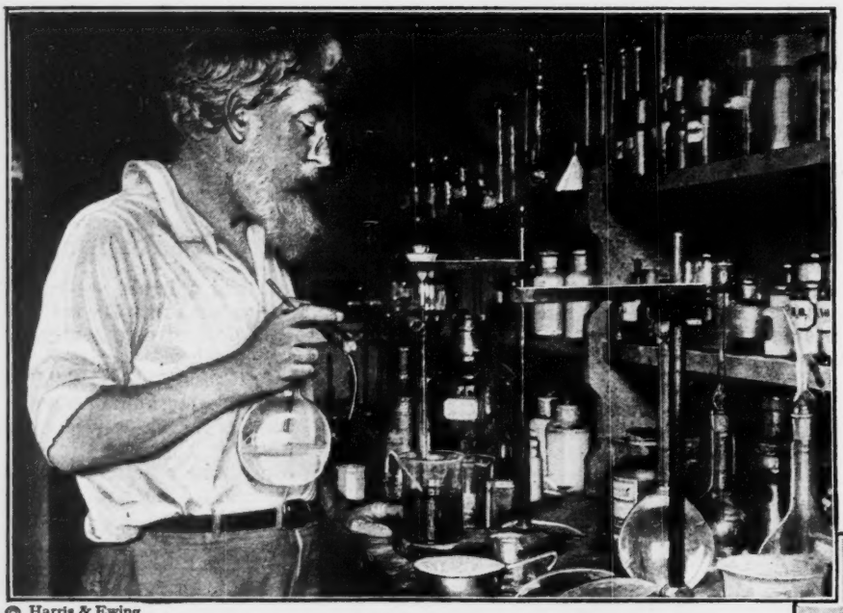
As proof he exhibited three photographic plates on each of which were unmistakable light impressions, caused, he asserted, by the rays emitted by a radioactive mineral, an insect, and a green leaf, which were placed on the emulsion side of the plates in a darkroom.

A similar experiment in which a dead insect and a dead leaf were used resulted in no ray impressions on the plates. Monsieur Nodon offered as his conclusion that radio-activity is an inevitable accompaniment of living processes, and stated that the strength of photographic impressions produced in experiments such as his are an accurate measure of vitality.

Super-Generator

AN ELECTRIC generator capable of developing 15,000 volts of direct current—from four to five times more than any direct-current generator previously built—recently was completed by S. R. Bergman, consulting engineer of the General Electric Company at Schenectady, N. Y. This machine is expected to influence remarkably many phases of electrical work, notably radio broadcasting.

At present long-distance broadcasting is accomplished by means of a rectified high-voltage alternating current, which produces ripples that affect the clearness of the transmission. But the use of direct current, supplied by generators of the new type, this defect will be eliminated.



© Harris & Ewing

By chemical analysis of lavas of the Hawaiian volcanoes, Dr. Henry S. Washington, world famous expert on the chemistry of the earth's crust, hopes to find some clue to the vast mysteries that lie beneath the Pacific Ocean. For example, there is the theory that the moon once was part of the earth and was pulled out of it millions of years ago, leaving a hole that became the bed of the Pacific. Another theory is that the continents really float on a semi-liquid layer, and that they slowly drift about, so that the earth's appearance a million years from now will be vastly different from the earth as we know it. The lava, it is believed, holds the clue to these mysteries

Are You An Only Child?

THE only child usually is regarded with pity. He is likely to be "spoiled," people say, to become selfish and to develop other undesirable traits as a result of parental indulgence, which the children of larger families do not receive.

Now, though, comes Dr. Hornell Hart, of Iowa, to state that the only child, far from being an object of pity, is rather to be congratulated. After a study of the children of 600 families of Davenport, Ia., Doctor Hart announces that the only child is brainier, more energetic, kinder, more sincere and more honest than children who have many brothers and sisters.

Doctor Hart's conclusions as to brains and energy were arrived at as a result of scientific tests; others are offered as the testimony of school authorities.

Meanwhile Professor H. D. Fish, of the University of Pittsburgh, supplies some highly interesting facts relative to heredity and the birth rate, the result of a study of more than 2500 families. If the second child is a girl, states Professor Fish, it will be born, on the average, 3.26 months later than if it is a boy, this being true no matter what the sex of the first child.

This difference in the time of birth probably is sufficient to explain the interesting fact that more boys are born than girls. Also, Professor Fish reports, the firstborn is more likely to be a boy than any of the later children.

If the parents are of different nationalities, Professor Fish finds, the chances are much greater that most of the children will be boys than if the parents are of the same stock. However a 20-year study of births and parentage, states Professor Fish, indicates that the preponderance of male children over female is slowly becoming less.

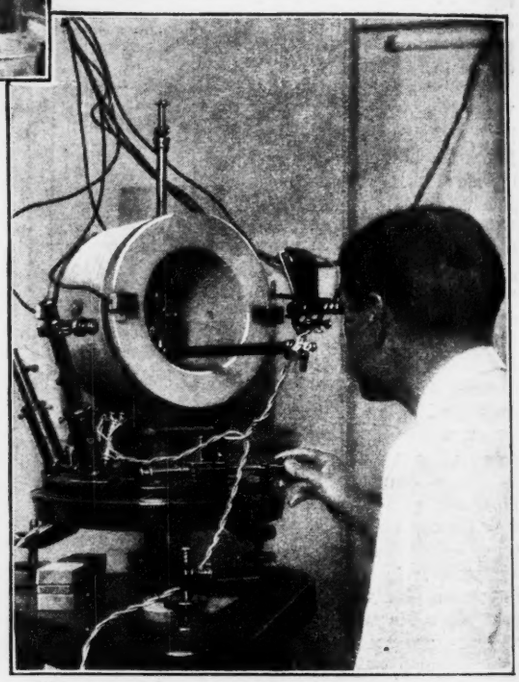
Dr. David Lumsden of the U. S. Department of Agriculture, who has made the amazing discovery that when the twigs of trees, the bulbs of plants, or other plant parts are exposed to a small dose of ether vapor, the plants can be made to wake up out of their winter sleep and to grow as actively as they usually do in the spring

"Forests" of Cotton Trees?

COTTON is due for a great rise, if plans of the Department of Agriculture are successful—not in price, however, for the department is merely seeking to persuade the cotton plant, which now grows close to the ground, to become a regular tree.

An experiment to bring this about is under way at the department's plant introduction garden at Miami, Fla. The plan is to cross the cotton plant with a relative, a rare Hawaiian tree called *Kokia Drynarioides*. Inasmuch as there is only one tree of this species known to exist, the plan cannot be put into effect immediately; but the government experts have succeeded in growing the trees from seeds obtained from the lone specimen in Hawaii, and are hopeful of eventual success.

So future cotton plantations may become cotton "orchards" or "forests," containing, instead of low shrubs, trees from 15 to 25 feet high, that will produce larger and better crops, and possibly result in cheaper cotton for the consumer.



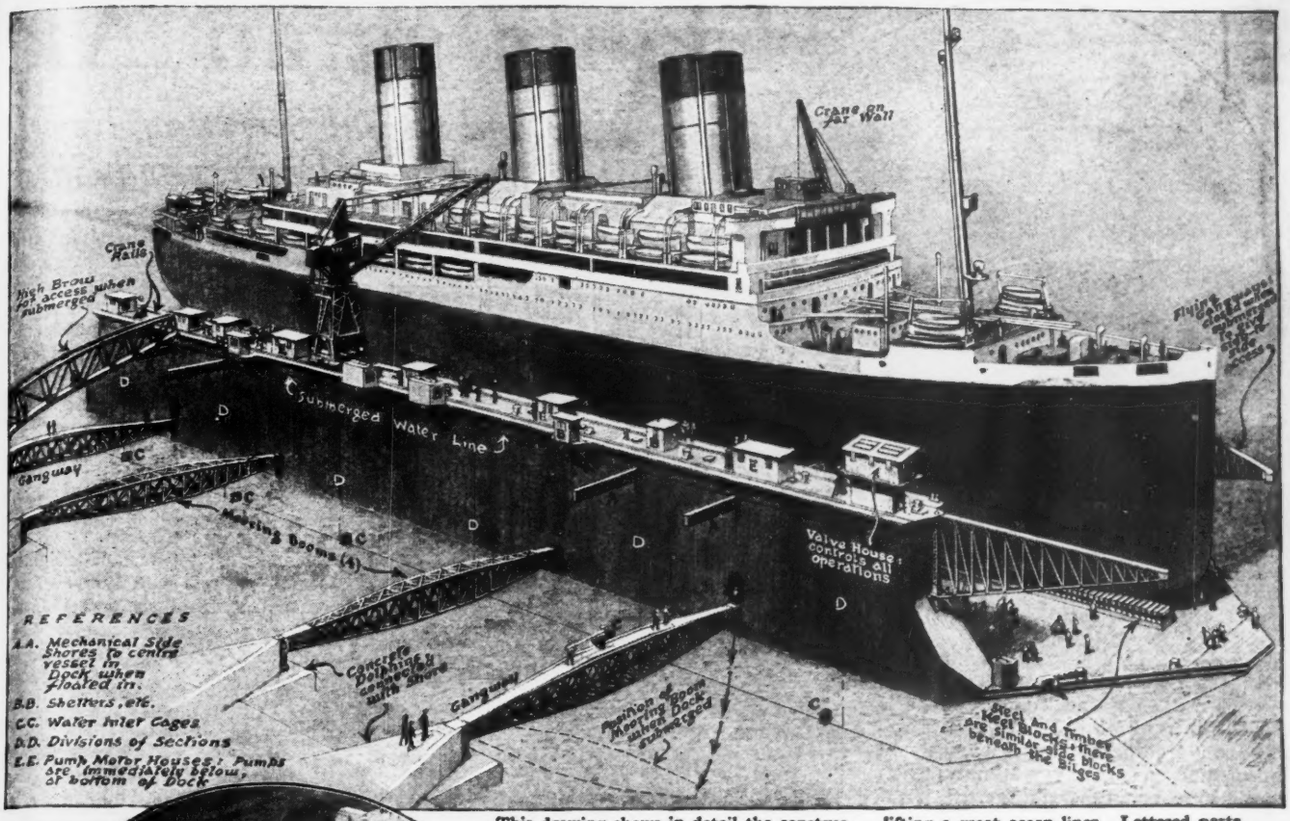
This apparatus, constructed by J. P. Ault of the Magnetic Laboratory of the Carnegie Institution, is the last word of science in the exact measurement of the earth's magnetic intensity. Variations in the earth's magnetism, it is believed, are responsible for many difficulties in radio transmission, as well as for the "magnetic storms" that occasionally play havoc with telephone and telegraph lines. If science can succeed in discovering what causes these variations, it may be possible to predict radio conditions in advance, just as weather is predicted

Worthy of Honor

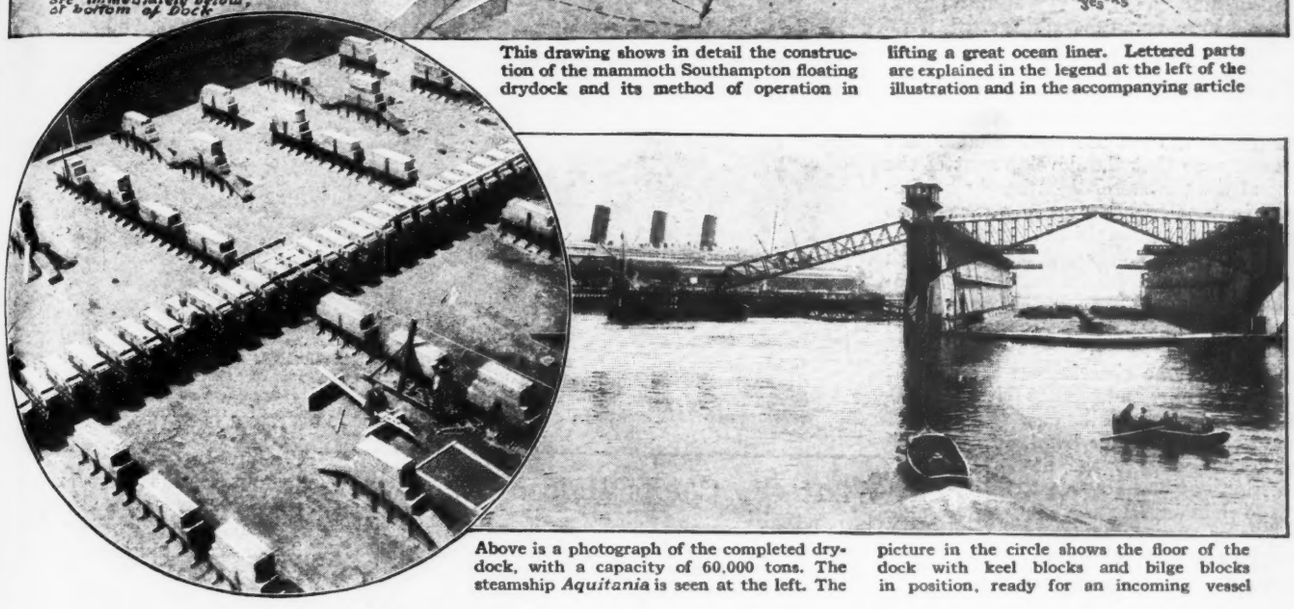
SCIENCE knows no international boundaries. It is not remarkable, then, that the Franklin Institute of Philadelphia, in conferring the Franklin medal this year, should have chosen Sir Ernest Rutherford, eminent British scientist, as the recipient of this, its most distinguished honor.

The medal is conferred upon Sir Ernest in recognition of his researches in physics. He probably is the world's leading worker in this branch of science. Indeed, a distinguished scientist has said:

"When some eminent men publish an experiment we say, 'This is very interesting; we must repeat it to see whether it is true.' But when Rutherford publishes an experiment all say, 'This is true; we need not repeat it'."


Crane on Air Wall
Crane Rails
High Brow for access when submerged
Submerged Water Line
Gangway
Mooring Booms (4)
Valve House; controls all operations
REFERENCES
A.A. Mechanical Side Shores to centre vessel in Dock when floated in.
B.B. Shelters, etc.
C.C. Water Inlet Cages
D.D. Divisions of Sections
E.E. Pump Motor Houses; Pumps are immediately below, at bottom of Dock
Concrete Dolphins connecting with Shore
Gangway
Position of Mooring Booms when Dock is submerged
Steel And Timber Keel Blocks are similar to those beneath the bilges

This drawing shows in detail the construction of the mammoth Southampton floating drydock and its method of operation in lifting a great ocean liner. Lettered parts are explained in the legend at the left of the illustration and in the accompanying article



Above is a photograph of the completed drydock, with a capacity of 60,000 tons. The steamship *Aquitania* is seen at the left. The picture in the circle shows the floor of the dock with keel blocks and bilge blocks in position, ready for an incoming vessel

The Largest Floating Drydock in the World

By S. W. Clatworthy

WHEN the Prince of Wales formally opened the largest floating drydock in the world recently at Southampton, England, that port made a bid to become the world's leading haven for the greatest ocean liners. Previously liners of the size of the *Majestic* and *Leviathan* were compelled to go for repairs to Hamburg or to Boston.

Lifting the 52,000-ton steamer *Majestic* will be a comparatively simple procedure in the new dock, since it has a lifting power of 60,000 tons. Built on the sectional plan, it can be enlarged at will by the addition of another section.

The over-all length of the dock at present is 960 feet; width 170 feet, and height more than 70 feet. In its construction about 3,250,000 rivets were placed.

When the dock is to be submerged to receive a vessel, water is admitted into compartments through special inlet pipes equipped with valves operated by hand and by an electropneumatic control system. Indicators show the depth of water in the various compartments.

The 14 main pump motors for ejecting water and thus lifting a ship are arranged so that there is one motor for each section. These motors are controlled by a press-button system from the valve house. A complete telephone system connects the valve house with each of the motor houses.

Because of the great weight of ships to be lifted, the blocks and supports are of unusual strength. On a continuous timber base running along the center of the dock are cast steel wedge blocks surmounted by a timber block. The bilges of a vessel are supported by timber blocks with steel bases. These are made adjustable to any ship.

A ship is centered automatically by four electrically driven side shores, arranged so that opposite pairs are geared together and driven by one motor. On each side wall is a three-ton warping capstan.

The dock is connected with the shore by four mooring booms 110 feet long, anchored to reinforced concrete dolphins.

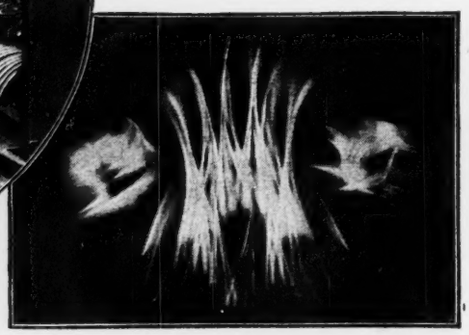
The electric-lighting system is designed so that the light may be concentrated on any part of the dock or ship.

Lights as an Aid

New and Useful Secrets of Colored Lights Depress and Cheer,

Thomas Wilfred, inventor of the "color organ," at the keyboard of his instrument

One of the striking light effects produced by the color organ appears below



By M. Luckiesh

EVERYBODY knows that music has the power to stimulate or to depress. No knowledge of music is needed for a person to react quite differently to a grandiose, martial air, a lively dance tune, a dreamy waltz, a sentimental song, or a funeral dirge.

Light and color have similar powers, although these effects have not been built generally upon definite, standardized principles. Adequate controllable artificial light did not become available until recently, so that the development of the use of the powers of light barely has begun in earnest, even among those who appreciate its possibilities.

Most persons recognize, although vaguely, effects of light somewhat analogous to those of music, but, of course, the two are not related simply, as some people assume them to be. Who has not responded to the cheerfulness of a bright sunny morning and has not felt its stimulating influence all day long? On the other hand, who has not felt the depression of an overcast, shadowless day?

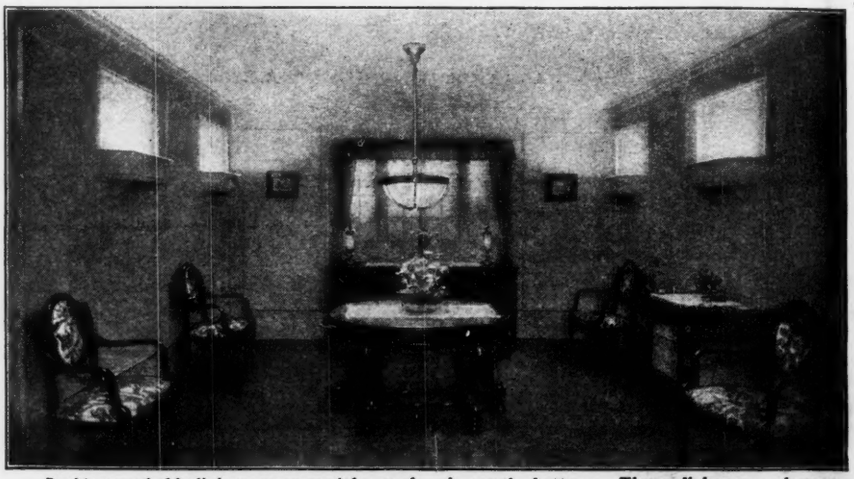
The great symphonies of the sunset hold us enraptured as we witness this benediction of the day. From the ever-changing lighting of a landscape we sense the parade of moods. The play of light from stained-glass windows of a cathedral breathes life into the restful scene. The delicate fire of the opal and the restless sparkle of the diamond are examples of melodies of light. On a large scale we have fireworks making their appeal in a more primitive manner, but still by the powers of light.

In the theater, light has been used to produce different moods. The meager, colorless light of the prison, the brilliant sunlight, and the pale light of the moon play their parts as definitely as do flesh and blood actors. From such realisms to the sparkling, colorful lighting effects of fanciful settings and unreal worlds is a gamut of powers of light. Even the auditoriums of theaters, dining-rooms of hotels, ballrooms, are beginning to utilize the powers of light. It is true that only a beginning has been made because, as in the case of music, we must not only learn how to "play" light, but its rendition must not proceed too far beyond public appreciation.

This new art and science of lighting has not entered the home to any extent, in spite of the fact that the introduction of variety into our homes is very desirable. Most persons light their homes merely with the idea of extending the "day" somewhat. They seem to think merely in terms of obtaining sufficient illumination for reading and other activities. They do not realize that artificial light can introduce beauty, charm, cheerfulness, restfulness, coolness, warmth, and other possibilities. The mobility of light renders it a medium much superior to paints, wall-papers, furnishings, and the other "fixed" media that have reigned supreme.

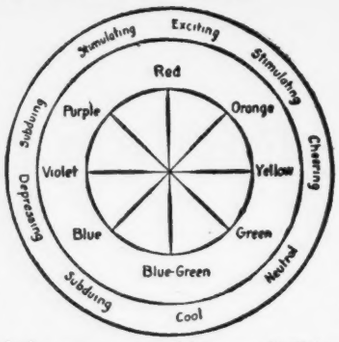
Light has power to make a house a home.

The psychological and physiological effects of color cannot be presented in detail in a brief article and there are so many ramifications that it is dangerous to



In this remarkable dining-room a special central fixture gives direct, indirect, and semi-indirect light, simultaneously, by means of an inverted, semi-transparent shade with an opening at the bottom. The wall boxes produce indirect light of three tints. The artificial window at the rear provides sunlight, moonlight, and sunset effects on the painted background

What the Colors Hold for You



THE little chart reproduced here was prepared by Mr. Luckiesh to indicate at a glance the general effects of various colored light upon our mental and physical condition. It is based on his experience as Director of the Lighting Research Laboratory, National Lamp Works of the General Electric Co.

Study it for a moment. Doesn't it define for you, for the first time, some of the vague feelings you have had about colors and their effect upon your moods? And doesn't it suggest surprising possibilities for lighting the rooms of your home?

Indeed, you will find that this simple chart, combined with Mr. Luckiesh's forward-looking story, is a wonderfully lucid introduction to a new science fraught with tremendous possibilities.

Mr. Luckiesh attempts merely to suggest some of these possibilities. He points out how the scientific arrangement of light and color effects not only will beautify our homes, but will bring us rest, contentment, health, and energy.

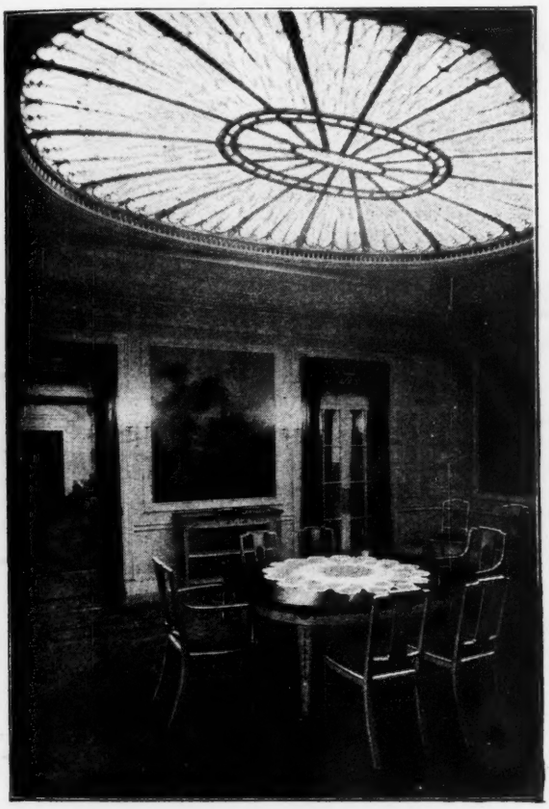
In short, he shows us how, by using color effects for our benefit, we can copy what Nature always has done to make the world a delightful place to live in.—THE EDITOR.

to Your Happiness

Illumination in the Home—How Subdue and Stimulate You

present anything more than generalizations. However, with this caution, the circular chart at the bottom of page 56 is presented to show the general effects of various colors upon us. The colors of the spectrum are placed in proper sequence around three-fourths of a circle, the remaining quadrant being given over to colors that may be called "purple." In modulating from violet to red we begin with violet-purple, and pass through purple, and finally reddish purple.

This color circle may be divided approximately into three parts in which the colors have certain characteristics that classify them respectively as stimulating, tranquilizing, and subduing. On the outer rim a further subdivision is attempted. At opposite ends of any diameter complementary colors are found.



Red, green, and blue lamps are concealed above the skylight of this dining-room. By blending these colored lights in various amounts, through the use of electric switches or rheostats, any tint of lighting may be obtained. Thus the family may dine in artificial sunlight, moonlight, or the rose color of dawn, as they desire

Colored light is very much more powerful than colored pigments. It tinges everything, while a colored vase, for example, extends its influence barely beyond its boundaries. We must take this into account if we are to be successful in producing desired lighting effects. A green vase may be just the proper note to complete a color-scheme, but a green light, if it illuminates the faces of our companions, may become very displeasing. Some colored lights should be confined to walls and ceilings, and they should be drowned out by warm light localized on the faces in the room.

We may have fairly neutral walls and ceilings in our homes, obtaining our color notes from furnishings. Then from hidden sources of light in fixtures, ornaments, wall-boxes, and architectural details we can make this wonderful medium—light—spring forth by pressing switches.

In general, it is well to confine the use of deeply colored light to secondary lighting. For example, in the dining-room we should have white light on the table and a light of a warm tint on the faces of the diners. This can be achieved by any pendent shades tinted a warm yellow-orange. The strongly tinted light may be confined to ceiling and upper walls.

IF A stimulating effect is desired, orange-red light may be emitted upward by a suspended bowl, by "flower-boxes" on the walls, or by large vases. A "cool" effect suggesting the outdoors can be obtained by using blue-green lamps or colored accessories concealed as suggested. Colored gelatines and colored glass accessories are available for this purpose. The "daylight" lamp also has possibilities when used in contrast with "warm" light.

Most of the foregoing color effects are not to be lived with constantly. Variety always emancipates us from the monotony of fixed decorative schemes. Portable lamps will be found valuable allies in introducing variety in lighting.

Those who have not experimented with the possibilities of light will find that light of the tint of the candle-flame is kind to human beings and to faded surroundings. It provides a glow that can be lived with, for it is consistent with our unconscious demand that the home be a place of comfort, protection, and cheerfulness.

With growing experience and understanding, man is going to demand more mobile light. He will want the light symphonies of outdoors brought indoors. He will want the charming melody of the opal and the brilliant light-music of the diamond reproduced by artificial light on a large scale. He is going to develop an "eye" for subtle effects of light, just as he has developed an "ear" for modulations of music.

In the application of the powers of invisible radiation, science has made only a beginning. Above is one of the latest developments in the use of the X-ray—a water-cooled, high voltage tube for the treatment of deep-seated cancer. It is the work of Dr. W. D. Coolidge, of the General Electric Company, who is seen in the picture with his apparatus

Some day we are going to have marvelous jewels of light and super-decorative schemes of light before which the decorator's effort today will be somber and feeble indeed. The lighting artist will be a super-decorator and a super-doctor in this new era.

Then there are other important fields for usefulness of light and its attendant radiations. For example, colored lights have certain chemical, biological, or therapeutic effects when applied to the body. But this phase of radiant energy from the sun or artificial sources is not confined to visible rays or colored lights. Radiant energy of shorter wave lengths, known as "ultraviolet radiation," is performing great services in such fields as the killing of bacteria and the prevention and cure of rickets.

IT HAS long been known that there is a seasonal variation in the prevalence and seriousness of rickets. In winter, when there is much less daylight, many infants show signs of the disorder, the floodtide being reached at the end of March. Ultraviolet radiation is found to be protective against this ailment.

Röntgen or X-rays of shorter wave length also are curing many diseased conditions. Then comes radium with its still shorter and more penetrating radiation. Miraculous cures are achieved. Tumorous growths and cancerous conditions, lying deep beyond the reach and skill of the surgeon's knife, are conquered by radium rays that pass through the normal tissues without permanent harm.

It is certain that only the feeblest beginnings have been made in the application of invisible radiation, extending from the visible region through the ultraviolet and X-ray regions and into that realm of

(*Continued on page 153*)

World's Smallest Plane Has 18-Foot Spread

THE world's smallest airplane, christened the "Fly," is the prized possession of the Army Aviation Corps at Kelly Field, Tex. Though the wing spread is only 18 feet, it develops a speed of 115 miles an hour.

The machine is equipped with a three-cylinder motor of 60 horsepower. It is of the radial type. The cruising radius of the plane is 500 miles and sufficient fuel can be carried for four hours' flying at full speed, or 5½ at cruising speed. The plane stands no higher than a man. Lieutenant D. Phillips, one of the army's pilots, is shown standing beside the midget at Kelly Field.

New Navy Plane Does the Work of Three

A SEA and land plane combining the functions of three planes of the usual types has been developed by the Bureau of Aeronautics of the Navy Department in collaboration with the American aircraft industry. The plane, known as the "CS," is designed for bombing, torpedo launching, and long-range scouting. It is said to be the lightest plane for its horsepower ever built.

Another important feature is that it is able to fly with more than its own weight as a load. In fact, tests have shown that with its single engine it is able to carry a greater load than the twin-engined bombers that have been in use for the past few years.

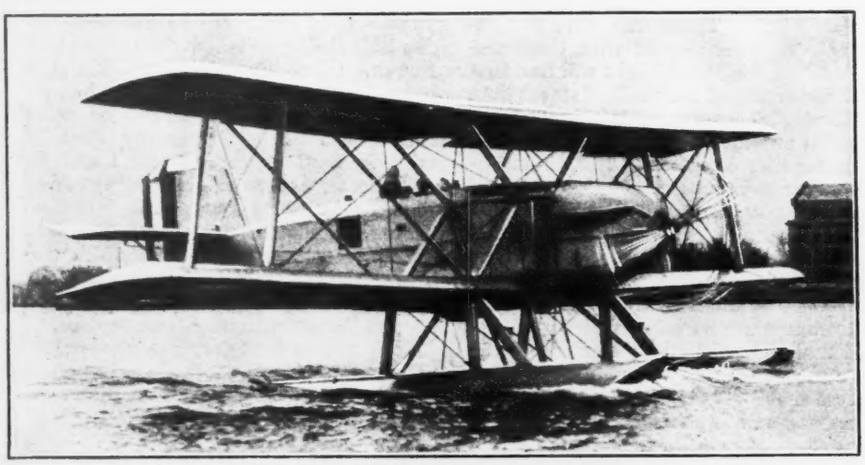
The CS plane is powered with a Wright T-2 engine of 650 horsepower. It is quickly convertible from a seaplane into a landplane, or vice versa. The weight of the machine is about 4000 pounds. Its wing spread is 56 feet, its height 11 feet, and its length 34 feet.

Fully loaded for a long flight, the CS carries 15 barrels of gasoline and one barrel of lubricating oil. It has a range of about 2200 miles, without landing and without refueling. Its landing speed is 55 miles an hour and as a landplane its maximum speed is 105 miles an hour.

The construction is of steel and duralumin except for the wings, which are made of wood and fabric, and are so designed that they can fold back, thus effecting a marked saving in space. This plane is also designed so that it can be launched from a catapult on the deck of a battleship.

Included in the equipment is a radio set for both sending and receiving, two machine guns, and lights for night flying.

Thirty-five of the new machines have been ordered for the navy.

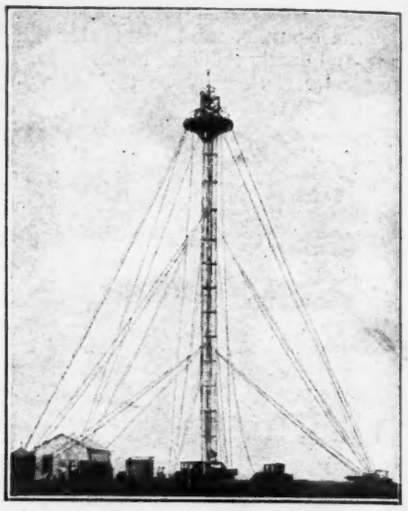


The new navy "three-in-one" plane during test flight at Anacostia, D. C.

New Mooring Mast Supplies Helium to Dirigibles

TO ALLOW dirigibles to "gas up" with non-inflammable helium gas, a helium-bearing mooring mast has been erected at the new government helium plant at Fort Worth, Tex. Up the center of the mast, which is 173 feet high, a large hollow steel pipe will deliver the helium gas into the body of dirigibles.

The mooring mast is located in the center of one of the most important helium deposits in the United States, in the north-central part of Texas. Here the safety gas is being produced in such increasing quantities that the cost is steadily decreasing.



Helium mooring mast at Fort Worth, Tex.

Amphibian Planes for Army Designed by Loening

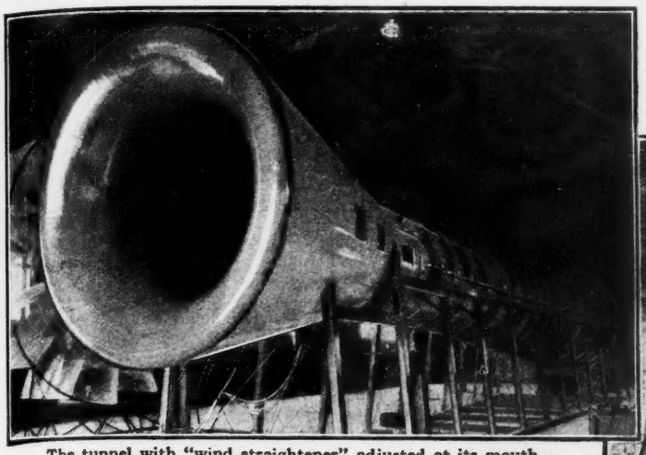
THE United States Army Air Service has contracted for the construction of 10 amphibian planes of an entirely new type designed by Grover C. Loening, president of the Aeronautical Chamber of Commerce and inventor of the flying boat, according to a recent announcement by Maj.-Gen. Mason M. Patrick, chief of the service.

The new design is said to represent the first successful flying boat that is completely amphibious, operating on land and water. In secret tests its performances are reported to have compared favorably in climbing and maneuvering ability with land type airplanes of equal weight and power. It has attained a speed of about 120 miles an hour.

The hull of the plane is metal covered, and metal is used largely in the construction of the wings. For service as a seaplane, the ship is equipped with pontoons. The landing gear, folded up underneath and at the side of the hull, is released when the pilot presses a button on the dashboard.

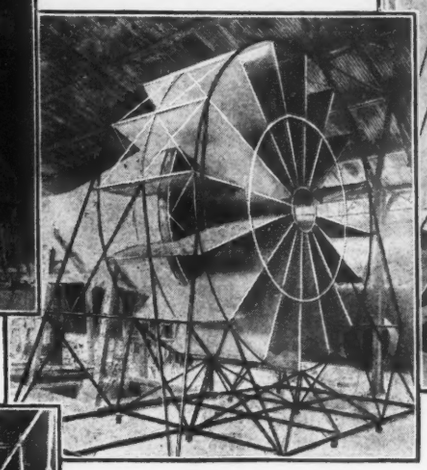
A feature of the design is the installation of the inverted Liberty motor, recently developed. This arrangement, in which the cylinder heads are at the bottom of the motor, puts the propeller hub at the top instead of the bottom, and as a result the motor is said to operate more effectively, while the oiling system is greatly simplified.

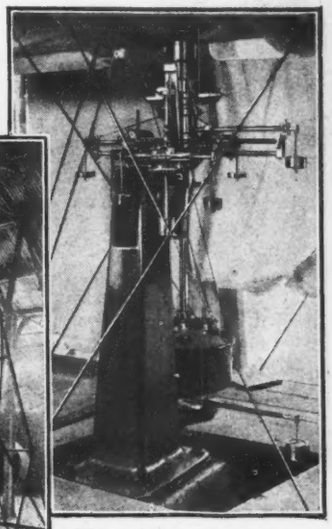
Flying Made Safer by Wind-Tunnel Tests



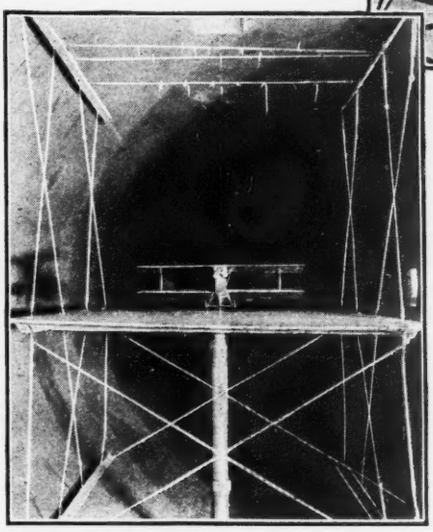
The tunnel with "wind straightener" adjusted at its mouth. This apparatus breaks up whirls and eddies in the air flow

Below is the exhaust fan that sucks the air through the tunnel, in imitation of the action of wind, which is caused when air rushes into cavities in the atmosphere





This balancing apparatus below the tunnel, supports the model airplane



A model plane, 1/24 the size of an actual plane, on the balance in the wind tunnel at McCook Field, where models are tested for stability and strength to take the guesswork out of airplane construction. The balance supports the model approximately as the air would in flight, while the midget plane is subjected to all kinds of wind conditions

THERE can be no guesswork in designing and constructing an airplane. The airplane must be perfect before it takes the air; otherwise it may be wrecked and lives may be lost. Yet the airplane designer has not the same chance as an automobile or marine engineer to make safe tests of his craft under actual operating conditions after it is assembled.

How to make certain that an untried airplane—particularly one of new design—is safe and practicable before it is subjected to a test of actual flying always has puzzled aviation engineers. The problem, however, has come closer to solution than ever before by the recent construction at McCook Field, Dayton, Ohio, of a "wind tunnel," in which miniature airplanes, exact scale models of the larger planes to be built, are subjected to precisely the same air strains that the real planes will encounter in actual flying.

In every particular save wires and fittings the tiny planes—their greatest dimension is about 20 inches—are identical with the larger craft they represent. They have cockpits, propellers, rudders, windshields; there are even little knobs placed in them to represent the heads of the occupants. The thin portions usually are made of metal, the rest of maple or some other close-grained wood that will not warp.

In ordinary pattern making, an error of 1/100 of an inch is admissible. These models must be accurate to 1/200.

The wind tunnel is five feet in diameter. Air may be drawn through it at any desired velocity by means of an exhaust fan. The model is placed in the "experimental chamber" in the center, and is supported by suitable balances, so that the forces caused by the moving air can be measured.

These balances, placed outside the air stream, are so delicate that air forces can be determined to within 1/10,000 of a pound.

Testing in the air tunnel is the last step in designing an airplane. That is to say, the model is not constructed first, but is prepared from the plans drawn for the actual plane after all engineering calculations have been made.

The tests are valuable for determining balance and stability. If the model passes the tests, it may be assumed that the design for the actual plane is correct. If the model fails to pass, the actual plane is not constructed and thus money is saved and life safeguarded.

U. S. Helicopters in Contest

OF THE 19 entries for the British Air Ministry's helicopter competition for a prize of £50,000, the United States heads the list with nine different machines. Great Britain is second with four, while France, Belgium, and Italy each have entered one.

Tests of the machines began August 1 at the British government's aircraft center at Farnborough.

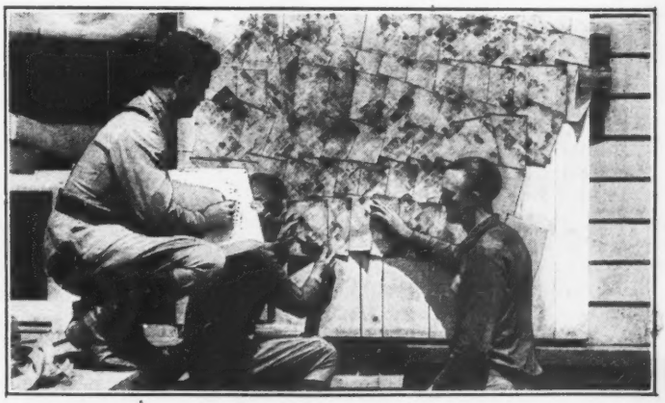
To win the prize, a machine is required to make a straight up-and-down flight, attaining an altitude of 2000 feet, a hovering flight of half an hour, a circular flight of 20 miles at 60 miles an hour, and a descent into a small area from 330 feet with the engine stopped. Such a performance never has been approached.

Map of Salton Sea Made from 2000 Photos

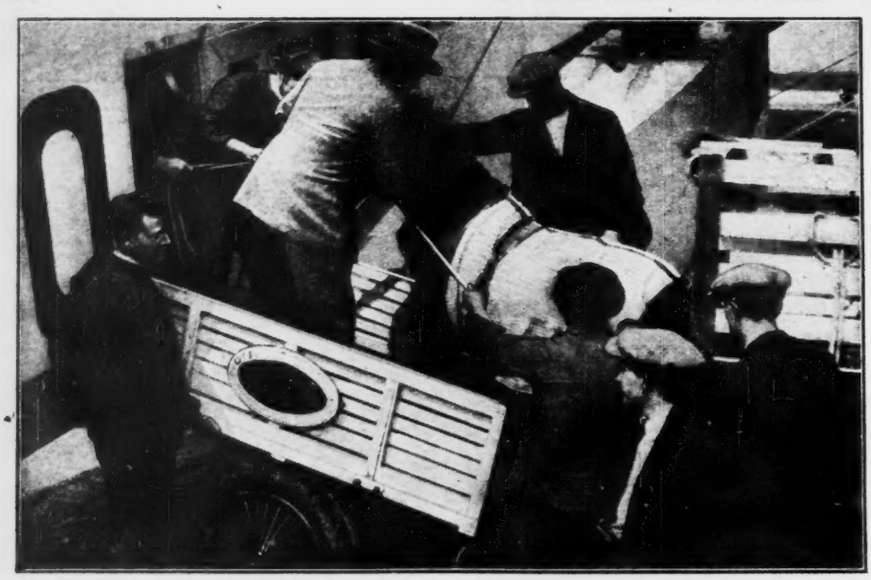
THE hazardous work of mapping the Salton Sea in southern California from an altitude of nearly 15,000 feet recently was completed by fliers of the United States Army Air Service.

In planes especially equipped for the purpose, the aviators took 2000 different photographs. After the negatives had been developed and printed, the prints were matched painstakingly together to form a complete map of the district.

During the work the pilots and photographers suffered from the extreme cold of the high altitude, even in extra heavy flying suits.



Matching the photographs together to form the map of Salton Sea



Suggestion Boxes Invite Ideas of Employees

TO PROVE to employees that there is money in ideas, and to encourage cooperation in improving working conditions and workmanship, a large electrical corporation at Schenectady, N. Y., recently installed boxes in various parts of the large plant where employees may deposit helpful suggestions.

The contributions are examined by a suggestion committee, and for the ideas that are accepted the contributor receives a cash award.

During the first year that this plan was tried out 908 suggestions for improvements in accomplishing certain processes, in ease of handling material, and conservation of waste, were accepted and $15,095 was paid out as prizes.

The plan proved so successful that it is now a feature of the plant.

Racehorse Flies from France to Holland

A FRENCH yearling colt owned by an attaché of the Dutch legation in Paris holds the distinction of being the first racehorse ever shipped by airplane from one country to another. The colt was transported from Paris to the owner's farm in Holland on a plane of the French Air Union especially fitted with an aerial horse stall.

On the journey through the skies the colt was accompanied by a stable boy to care for it on the way. Three other passengers interested in the experiment traveled in the same plane.

The photograph shows the colt being transferred from a wagon to its stall in the body of the airplane.

Placing a suggestion in the box

The Most Valuable Egg

THE most valued egg in the world is that of the great auk, a bird that once abounded in the regions of the North Atlantic, but that is now extinct. The last auk egg sold brought a price of about $2500

The auk was a diving bird, about the size of a duck, but was unable to fly because of its small wings. It laid one egg at a time. The birds and their eggs were used largely for food among seafaring folk. So many of them were killed that the species has entirely disappeared.

Electric Shock Warns Fish

AN ELECTRICAL method of saving fish from death in the irrigation canals of the West has been invented by an engineer of the General Electric Company. It consists simply of warning the fish to "keep out" by giving them an electric shock. This is done by the use of electrodes immersed in the canal, with electric current flowing into them.

It has been discovered that the resistance to electricity is greater in water than in the body of a fish, and that if a fish swims in the vicinity of two or more electrodes, it receives a shock that causes it instinctively to dart away.

In the past, mechanical devices such as screens were employed unsuccessfully.

Butterflies and Liquor

RECENT experiments by a British zoölogist have led to the discovery that male butterflies like to get drunk, while the females shun liquor. The butterflies were placed in a screened garden with bowls of whisky and water. The males invariably took to the liquor.

Sturdy Bungalow Made of Old Newspapers

A HOUSE of cards is proverbial for instability, but that a house can be made of old newspapers, and still serve as a durable dwelling has been demonstrated by Ellis Stenman, at Rockport, Mass.

With the aid of his wife and daughter, Stenman built a bungalow entirely of shingles made of old newspapers compressed and glued together. The house is shingled both inside and out with this odd material, which is covered with waterproof varnish. A number of windows are provided, making the "newspaper home" light and airy.

Attractive Massachusetts bungalow built of newspaper shingles

Chemistry Supplies Police with New Weapons

ONE of the newest of chemistry's contributions to the police war on crime is a burglar-proof cash-carrying case. Just inside the cover is a gas bomb that explodes if the bag should be opened by thieves who do not know of the safety catch.

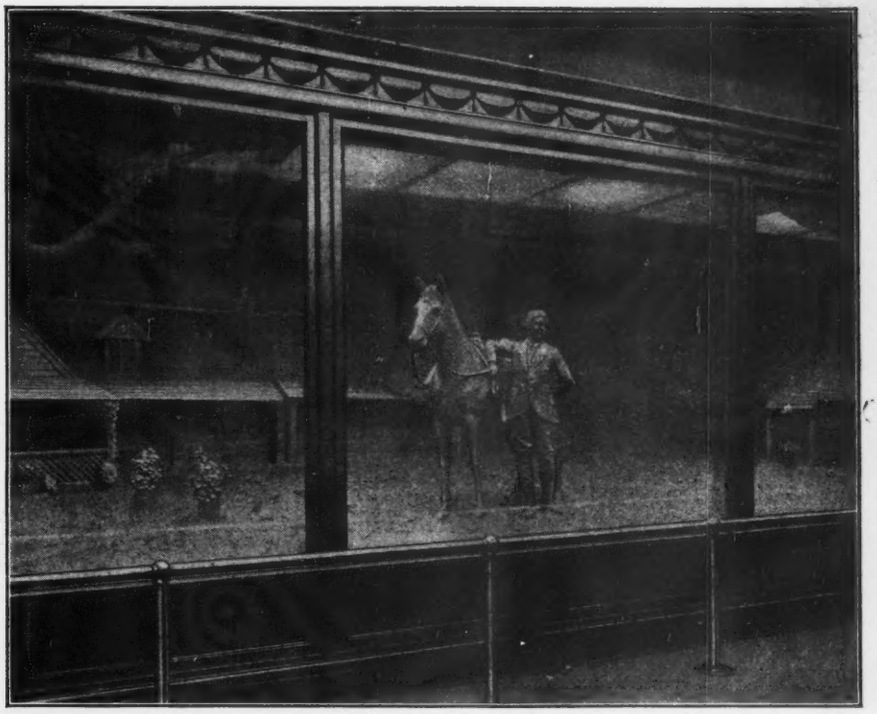
Another effective weapon (at the left) is a policeman's club containing a tear-gas bomb at the end of it. On the right is a chemical device for protecting a bank cashier's window from the depredations of bank bandits.

When these safety devices come into wide use, the inventors believe they will serve as a powerful check to banditry of all kinds. The use of tear gas already has proved its worth in aiding officers to cope with desperate criminals.

Police safety case and gas weapons

A Lone Survivor

THE maidenhair tree, introduced to the Occident from China and Japan, is the only survivor of an extensive family of prehistoric plants. It grows 100 feet tall and has leaves resembling a maidenhair fern.



The Prince of Wales Sculptured in Butter

ONE of the many unique exhibits at the British Empire Exhibition at Wembley, England, is a statue of the Prince of Wales standing beside his horse, done entirely in Canadian butter and housed in a special cabinet kept cool by a special refrigerating plant so that the work of art would not melt away during the exposition.

In the background is an accurate replica of the Prince's ranch house in Alberta, Canada. Two and one half tons of butter were used and two sculptors of the Canadian Government Commission—George D. Kent and Beauchamp Hawkins—labored for several days in a temperature of two degrees below zero while they were completing the work.

The lifelike statue is of especial interest in view of the Prince's visit to the United States this fall to attend the international polo matches between America and Great Britain at Meadowbrook, L. I. This is the first time in 10 years that this polo classic has been played in the United States.

The visit was made at the invitation of the United States Polo Association. A number of the Prince's polo ponies were shipped to America.

Swarm of Bees His Bonnet

THE latest thing in daring styles in headgear is a bee bonnet and chin strap of live bees. The brave wearer is Frank Bornhofer, of Tobasco, Ohio, a raiser of honey bees, who gathers them about him in this strange manner just to show on what friendly terms he is with them.

He performs this feat, he says, without suffering a single sting. All of which would seem to indicate that bees are not likely to molest a person who knows how to handle them.

Farm Wagon de Luxe Built from Old Auto

A DISCARDED motor-car was utilized in an ingenious manner by an Illinois farmer to build a smooth-running rubber-tired farm wagon.

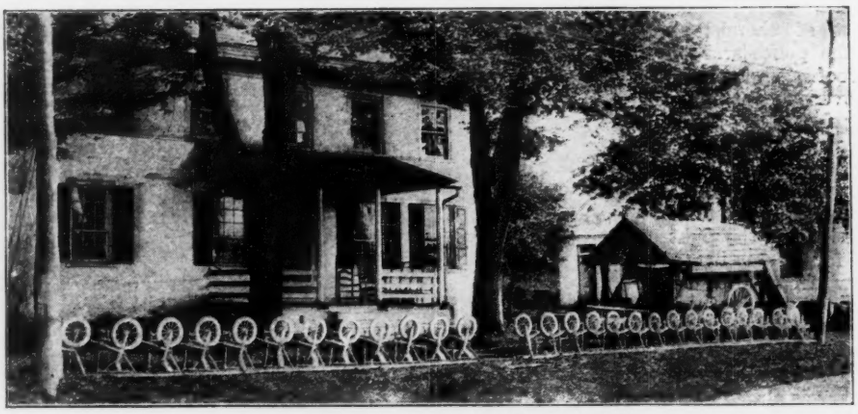
He removed the body, motor, transmission, and propeller shaft, after which he fitted a wagon body to the chassis. Then, by a method of his own invention, he fitted a wagon tongue in such a way that his team of horses pulls on the frame but steers the chassis by the original steering knuckles and tie rod.

Equipped with pneumatic tires, the combination makes a wagon which the owner says makes hauling a pleasure over even the roughest roads.

The automobile-wagon drawn by a team of horses

Fence of Spinning-Wheels Is an Unusual Advertisement

WHAT is probably the only spinning-wheel fence in the world has been erected by Elmer Zimmerman, a dealer in antiques in southern Pennsylvania. Thousands of motorists traveling along the William Penn Highway, which skirts this curious exhibit, are attracted by the unusual sight, and undoubtedly many sales of the antiques to be found inside the house have been made because of the appeal of tradition behind this graceful advertisement.



At the right of the house may be seen a historic four-horse Conestoga wagon covered by a rustic shed with a roof that is built of earthen tile. While placing these tiles when roofing the shed, Mr. Zimmerman discovered lettering on some of them stating that they were baked in 1746.

AN "ELECTRIC" beehive, said to have resulted in increased output of honey, has been perfected by M. R. Borlase Matthews, British inventor. The beehive is lighted and heated by electricity during the winter, with the result that the bees start to collect honey earlier in the spring than usual.

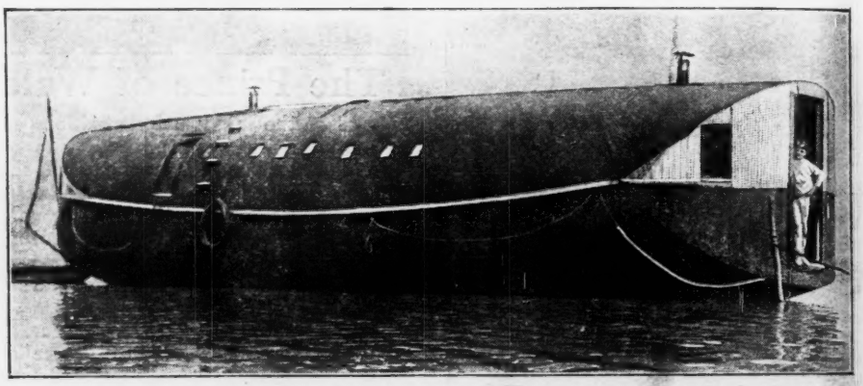
Plans to Swim the Channel in a Rubber Suit

MANY attempts have been made to swim across the English Channel, but none more unusual than that planned by Miss Zetta Hills, British champion swimmer, who will wear a suit of rubber especially designed for the purpose.

The suit is intended to protect the swimmer's body from the cold during her long journey in the water. Since it allows free movement of the limbs, Miss Hills believes it will not retard her progress.

Zetta Hills wearing her rubber suit

Baltimore Man Builds Modern Noah's Ark



A MODERN Noah's Ark has just been launched in the Mud Islands near Baltimore, Md. The odd craft is 50 feet long, 12 feet wide, 12 feet high, and contains six rooms.

The "ark" is to be modernized by the addition of two gasoline motors and electric lights, after which the builder, Allan Risley, and his family, will go cruising.

New Sandpaper Lithography

WHILE studying art in Paris, Norman Jacobson, of Coketown, Wyo., accidentally discovered a new method of lithographing that promises to provide endless recreation and interest for the artistically inclined.

The young American etcher picked up his ink-roller one day and, without thinking, he rolled it over a piece of sandpaper. He noticed that the sandpaper would not take ink. He then drew a design on it with wax crayons and inked the sandpaper, with a result not unlike that obtained from a regular lithographing stone, but accomplished without the expensive stone. It is said that brilliant effects can be obtained by using an ordinary clothes-wringer as a printing-press.

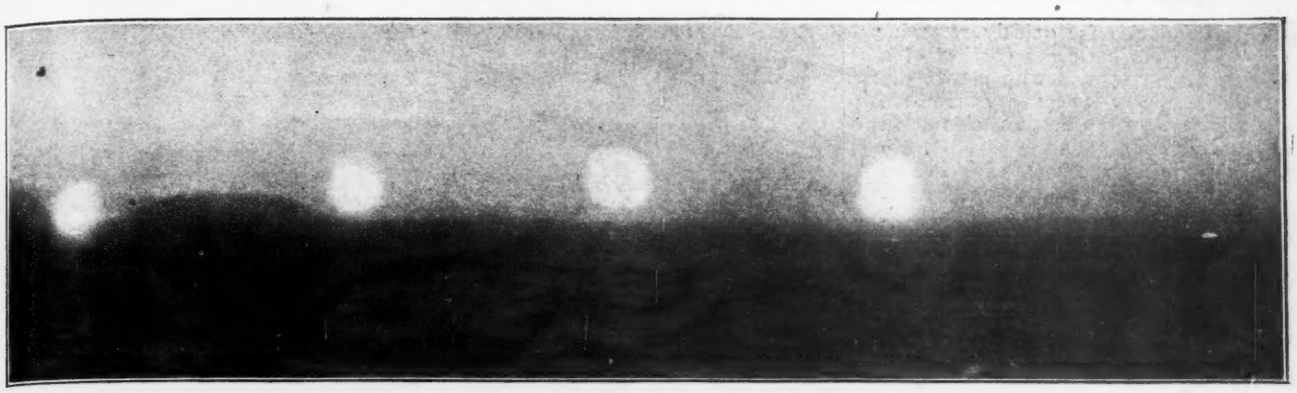
Mr. Jacobson says that the discovery will be of especial value to schools, as no expensive equipment is needed. The negatives need not be drawn. Silhouette pictures cut from magazines will give a similar result pasted on the sandpaper, inked and run through a wringer.

How a Queen Bee Travels

HANDY little bee containers are used in shipping thousands of queen bees through Uncle Sam's postal service each year. The containers are hollow blocks of wood with screens. The royal bees are put in a compartment with a piece of candy to dine on.

Boxes of queen bees ready to mail

Four Hours of Sunshine in Alaska in Midwinter



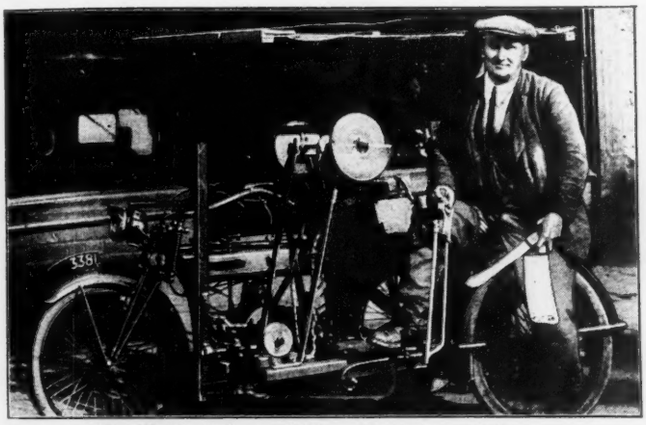
THIS remarkable picture from Alaska shows four positions of the sun during four hours when it appeared above the horizon in the month of December.

At the left the sun may be seen rising at 10 A.M. Next is its position at 11 A. M. In the center is shown its position at noontime, then at 1 P.M. and finally at the right, its setting at 2 P.M. Five photographing exposures were made to form the picture.

Because that part of the earth is turned away from the sun in the winter, perpetual night reigns in the arctic regions for months at a time.

During the short time that the sun may sometimes appear, it is so weak that it has little effect, either in light or in warmth.

Motorcycle Is Power Plant and Conveyance



The Welsh tinker and his motorcycle workshop

A TINKER de luxe who tours from village to village by motorcycle is now plying his trade in South Wales. Grindstones and attachments are so arranged that the motorcycle engine runs them. When work is done, the power may be turned back to its original use and the owner chugs off with his outfit to the next field of action.

This ingenious device is much more effective than the old-fashioned treadle method and the tinker is able to cover considerably more ground, so that if one village offers little work, he quickly moves on to the next. The notice that the unusual outfit attracts also serves as an advertisement.

Plastic Ball for the Ears Shuts out Sound

BECAUSE the street noises of Paris have become so great, a chemist has perfected a tiny plastic ball that will fit any ear without danger of injury to the drum.

It is recommended to "light sleepers, nervous persons, or invalids whose recovery depends on sound sleep, and to intellectual workers." Swimmers, too, are assured that the little balls will keep their ears free of water.

Chinese Workman Carves the Smallest Ivory Skull

SCARCELY as big as a tooth, the tiniest skull in the world was brought recently to the United States. It took infinite patience and skill at the hands of a Chinese workman who labored many months to complete the curiosity. It is complete in every detail and carved from a minute piece of ivory, small enough to fit on the tip of a pencil, as shown in the illustration below.

Tiniest ivory skull on pencil point

Opticians Are Now Offering Rectangular Eye-Glasses

GLASSES may soon be adjusted to suit the individual as easily as a collar may be bought to suit a man's neck, if we follow the latest fad that comes from Germany.

The Germans now make spectacles with movable rectangular lenses that can be changed about to best fit the face or taste of the wearer merely by shifting the frames.

Rectangular eyeglass frames

The United States' opticians have given thought to the same subject, but until now have retained the circular lens merely changing the type of the frame to gold or tortoise-shell.

Acetylene Sound Signals Used on Lighthouses

ON THE lighthouse of Dhuheartach, 15 miles or more from the west coast of Scotland, an automatic acetylene detonator is used in conjunction with the light. Once started by the lighthouse-keeper, it gives forth its warning every 30 seconds. Placed above the lantern, the sound can be heard in all directions.

Before the adoption of this device, the keeper had to set off the signals by hand, so that it took five minutes to set one off instead of the 30 seconds taken by the automatic device.

In the absence of a keeper, the setting off or the stopping of the signals can be controlled by electric buttons from the shore, by means of a cable to the light-house.

In Scotland again, in the estuary of the Clyde, there are two of these sound signal stations, and they are controlled by wireless from the shore, the wireless emissions opening the acetylene chamber valves and releasing the detonator.

Cleanser in Handy Bottle "Knocks" Spots off Clothes

A NEW device for quickly removing spots from garments consists of a bottle of cleaning fluid with porous cap attached. All that is necessary to remove a spot is to turn the bottle upside down and rub the cleanser on the garment. No rags are required and there is said to be no evaporation or objectionable odor. The cleanser penetrates the cap in correct quantity for use.

The makers of the cleanser claim that no fabric is too delicate for its ministrations, and that it will save many a trip to the cleaner's.

The little bottle will be found particularly useful in the week-end bag or to tuck away in a corner of the car when going on a tour.

Removing a spot with the cleanser

THAT one man's meat is another man's poison is well illustrated by a newspaper item that states that Ohio recently imported 7000 wasps from France. The wasps are brought to this country to fight the corn-borer, and if they do all that is expected of them, they will save millions of dollars yearly. Ohio needs the wasps and France is glad to be rid of them.

Grain Easily Unloaded by Use of Platform

TO ELIMINATE a great amount of handling and to increase the speed of unloading grain from grain wagons in western Canada, simple automatic unloading platforms are devised by cutting a section of planking from the unloading platform and hinging it in the center. Another section is placed so that the wagon wheels will track when driven over it.

A cradle arrangement is provided with tipping apparatus that lowers the rear wheels and raises the front ones, thus permitting the load to be dumped easily.

Atoms of Atoms

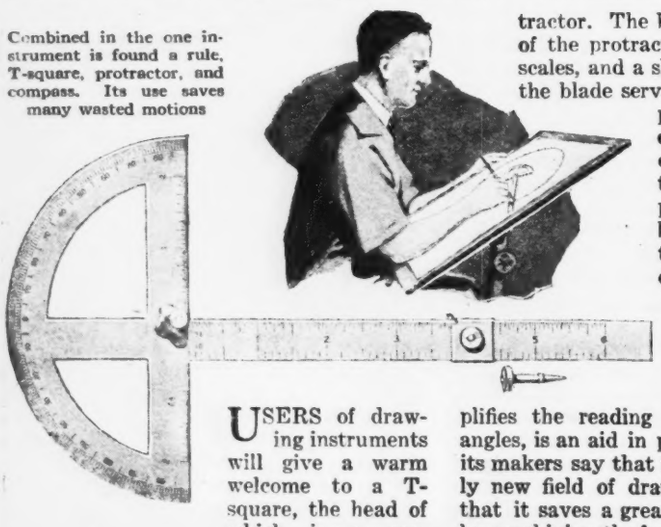
EVEN after the phenomenon of radioactivity pointed the way to the discovery that all matter was composed of infinitely small charges of electricity, science still clung to its theory that the atom is the smallest particle of a substance that could exist and retain the properties of that substance.

Recently, though, science discovered that atoms can be subdivided further without losing their identity. These chips from atoms science calls "isotopes." They are the atoms of atoms. An atom of gold, according to the new theory, would be made up of many isotopes, each composed of a different kind of gold.

Eight different kinds of tin compose an atom of tin, say the physicists who accept this amazing theory, and other substances are equally complicated.

Four Drawing Instruments Contained in One

Combined in the one instrument is found a rule, T-square, protractor, and compass. Its use saves many wasted motions



USERS of drawing instruments will give a warm welcome to a T-square, the head of which is a protractor. The blade and lower edge of the protractor are marked with scales, and a sliding attachment on the blade serves as a guide for the pencil when drawing exceptionally large circles with the center of the head as a pivot. The pin shown below the rule holds the instrument to the drawing-board.

The invention combines rule, T-square, protractor, and compass or dividers. It simplifies the reading or determination of angles, is an aid in plotting land, in fact, its makers say that it opens up an entirely new field of drawing technique, and that it saves a great deal of lost-motion by combining the four instruments in one.

Six-Inch Slide Rule Gives Accurate Calculations

ALTHOUGH only six inches long when closed, a new slide rule, with divisions marked on a spiral, has the same accuracy as a straight slide rule 66 inches long. Two cylinders are used, one sliding inside the other and both carrying scales. They are connected by a short blank cylinder on which two arrows are engraved.

For general calculations the lower arrow is placed opposite one given figure on the lower scale, then the upper cylinder is slid down into the first one until the second given figure appears opposite the top arrow. The result is shown on the upper scale by moving the bottom arrow to the top one.

One night in this vault, after an application of a fumigator, will rid furniture of moths

Workmen moving furniture into the steel-incased vault for fumigation against moths

Fumigating Vault Kills Moths in Furniture

MOTHS in furniture may be destroyed quickly without removing any of the upholstery, according to the inventor, by placing the piece of furniture in a fumigating mothproof vault overnight. The vault is constructed of specially prepared wood, chemically treated and incased in steel. It is airtight and the fumigant is sufficiently penetrating to kill all moth life in one application without harming the upholstery, it is claimed. The dimensions are 10 feet wide, eight feet deep, and six feet high. Smaller cabinets are also made to keep clothes in.

THE ailanthus tree, rapidly becoming a weed menace to New York and Pennsylvania, is said to produce a high yield of pulpwood, found to be suitable for book paper.

Knob Controls Automatic House Guard Lock

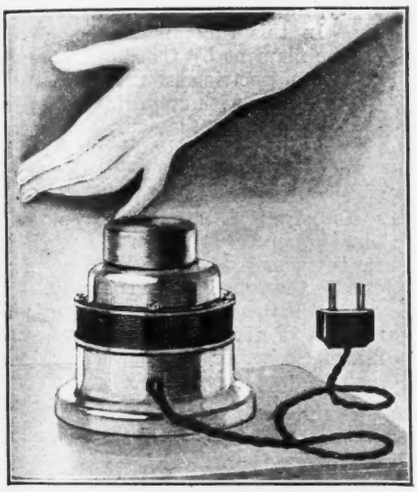
AN AUTOMATIC guard lock for doors takes the place of the usual chain and slot for allowing a door to be opened partly while still keeping it locked. By turning the knob to the right, the new lock automatically engages the guard that is attached to the door-jamb, allowing the door to be opened only to the end of the guard.

By turning the knob to the left the door may be opened without engaging the lock.

As the lock has no keyhole that may be reached from the outside, it forms a positive burglar device when left on continually.

This guard lock is burglar-proof

ACCORDING to a report from the Chemical Society of England, synthetic marble, capable of taking a high polish, has been made recently by heating hydrated sodium carbon, paste of precipitated chalk and a solution of common salt for eight hours at a temperature of 300° C. and a pressure of 24 atmospheres.



Electric Finger-Nail Polisher Saves Time and Labor

NO LONGER will a woman have to spend much valuable time in polishing her finger-nails. A French manufacturer has brought out a device that does the task in two minutes or less, depending on the height of polish desired.

All that is necessary is to hold the hand next to the buffer and let the machine do the rest.

The machine consists of a miniature electric motor with attachment for connecting it with the standard lighting current, and a buffer mounted on the axle. When the motor is turned on, the buffer automatically revolves rapidly, polishing the nails in a few moments without harmful friction.

SOME day we shall be using 1,000,000 volts in electrical transmission. Such a line could transport more than 1000 miles of energy, which is equivalent to power generated by 25,000,000 tons of coal.

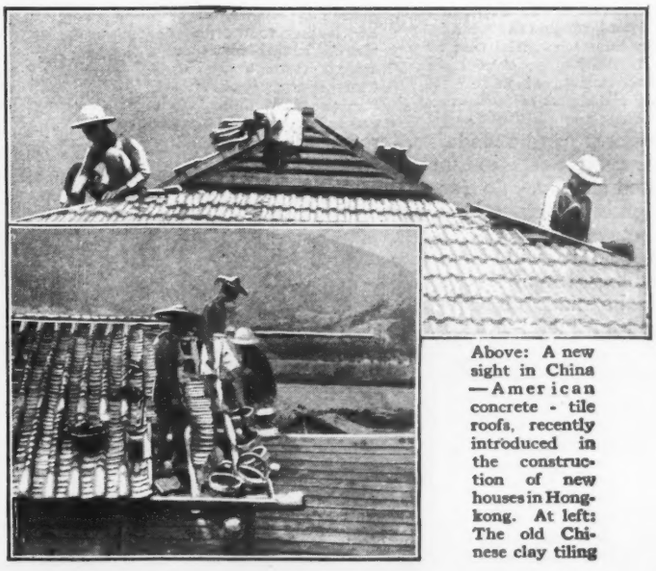
A Tube 210 Miles Long

A STEEL tube, 16 inches in diameter and 210 miles long, which, when completed will be one single piece, is under construction between Beaumont, Tex., and the natural-gas fields near Shreveport, La. That a jointless tube of such tremendous length is possible is due to the fact that every junction between sections is sealed by oxyacetylene welding. Ordinarily they would be joined together by screw couplings. This pipe line which will carry natural gas to Beaumont, crosses two rivers, many creeks, and runs underground through four counties.

China Adopts American Concrete Tile Roofs

IN CHINA, concrete roofing tile is taking the place of the ancient clay tiles. American machines in Hongkong are making concrete tile and brick for 250 houses to be erected at a cost of about $7000 each. They will be two-story houses having six rooms. Hongkong's housing shortage is so great that every one of the 250 dwellings was sold before it was completed. Fourteen million brick will be used in the garden walls that will surround the houses in English fashion.

Sand used for the manufacture of the roofing tile is brought to the plant by Chinese women, who carry it from a pit in a near-by mountain by means of baskets hung over their shoulders. The makers turn out about 11,000 bricks a day and 3000 tiles.



Above: A new sight in China—American concrete-tile roofs, recently introduced in the construction of new houses in Hongkong. At left: The old Chinese clay tiling

New Mileposts in Radio

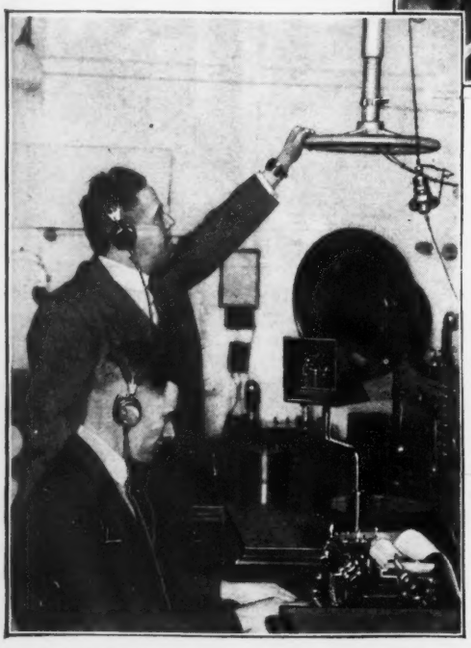
Recent Contributions to the Progress of Broadcasting

By Jack Binns
America's Most Popular Writer on Radio

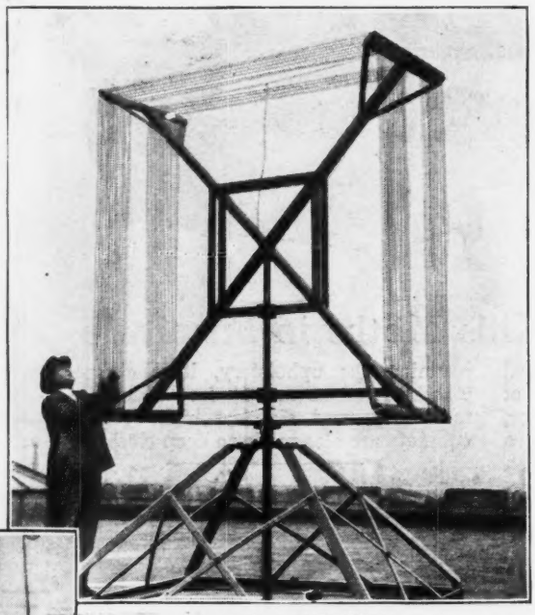
CHEAPER vacuum tubes and marked changes in the types of tubes commonly used seem to be foreshadowed by the fact that the last basic patent on the vacuum tube will expire early next year. Many radio engineers now are concentrating their efforts on the development of new types of tubes. Undoubtedly the expiration of the patent will result in an increase in the number of independent manufacturers, and that should mean lower prices to the radio listener.

Though many rumors are heard regarding the future plans of the leading manufacturers of tubes, only one definite announcement can be made, and that is that a new tube to replace the 201a will be introduced shortly. So far as current consumption is concerned, this will stand midway between the UV-199 and the UV-201a, and it will have characteristics resembling those of the latter. Its base will be made of heat-resisting glass instead of metal-incased porcelain.

Though the filament of the new tube will consume slightly more current than the UV-199, it is expected that it will be suitable for dry cell operation, except in large multi-tube sets. The introduction of this new type of tube will affect many radio enthusiasts, especially, of course, those whose sets are designed to use only 201a tubes.



R. H. Redmond, European Radio Supervisor of the U. S. Shipping Board, turning the steering-wheel that controls the huge loop aerial that he designed. Seated is L. F. Butler, chief radio operator of the London station, which receives wireless messages from a distance of 8000 miles



This gigantic loop aerial, said to be one of the largest in Europe, was erected at the top of a London office building recently by the U. S. Shipping Board to pick up messages from the United States. The aerial, measuring eight by eight feet, is wound with 48 turns of wire 1536 feet long. It is turned by means of an auto steering-wheel located in the operating room (left)

New Transmitting Tubes

TRANSMITTING tubes, too, are receiving their share of attention. Last year engineers of the Bell System developed a powerful new type the largest of which has an output of 100 kilowatts—200 times the power of a typical large broadcasting station. These tubes, you may recall, have their plate element on the outside, sealed to their glass walls.

Now these tubes are being made in smaller sizes and incorporated in a special type of transmitter, which makes them available for use on ships. The United States government has adopted them, and is installing them at present on the "Rum Fleet" cruisers patrolling the Atlantic coast to prevent liquor smuggling. Similar sets will be placed on navy destroyers.

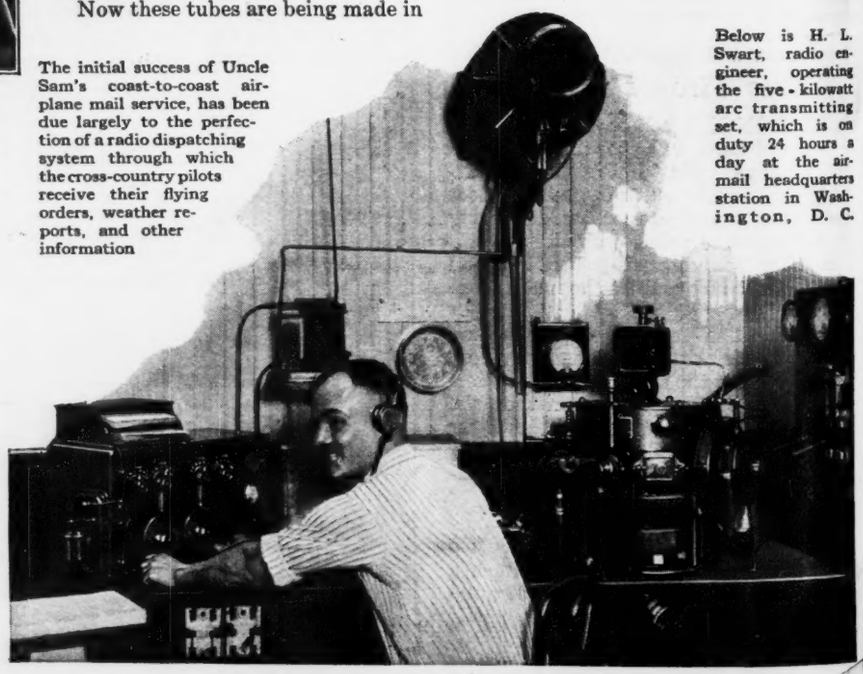
Using House Current

IT IS interesting, too, that the present widespread activity in vacuum-tube development may lead to what long has been a dream of radio inventors—a practicable method of employing house electric current in place of batteries.

Several schemes for its achievement have been described in this department, and now Dr. A. W. Hull, of the General Electric Company, attacks the problem from an entirely new angle by his invention of a novel type of vacuum tube.

In this tube, instead of heating the filament by the direct introduction of electric current, the current is connected with an ordinary tungsten electric lamp filament, which does not enter the radio circuit. Fitting snugly over this filament is a thimble-shaped element of a metal alloy capable of a high rate of electronic emission. When the tungsten is heated, the heat is transmitted to this element, which actuates the tube in the usual way.

Since the tungsten is not connected with any part of the radio set, it makes no difference whether it is heated by direct or alternating current, nor is there any danger of either the set or the operator using it being injured.



The initial success of Uncle Sam's coast-to-coast airplane mail service, has been due largely to the perfection of a radio dispatching system through which the cross-country pilots receive their flying orders, weather reports, and other information

Below is H. L. Swart, radio engineer, operating the five-kilowatt arc transmitting set, which is on duty 24 hours a day at the air-mail headquarters station in Washington, D. C.

The Radio Lighthouse

RADIO has brought about many changes in present-day life. Now it seems likely to cause the elimination of a useful and picturesque institution that has endured ever since ancient man lighted his beacon fires to guide the home-coming mariner—the lighthouse.

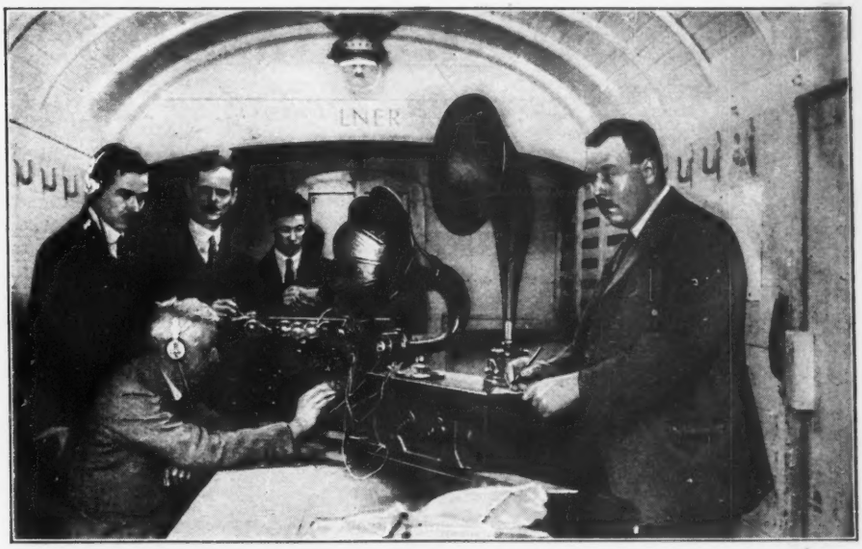
The lighthouse service of the Department of Commerce is conducting a series of important experiments with the radio beacon, or radio fog signal on the lightship at Nantucket Shoals, where all transatlantic shipping converges. The radio beacon depends for its efficacy on the difference in the speed of sound waves and radio waves.

From the lightship radio signals and sound signals from a submarine signaling device are transmitted simultaneously. The former travel 186,000 miles in a second, the latter only 1000 feet in the same time. The radio signals, then, will be received by a ship virtually the instant they are sent, and, from the length of time that elapses before the sound signals are received, the distance of the ship from the source of the signals can be calculated.

Special clocks have been designed for ships, which automatically convert this difference in time into distance in miles. A radio compass enables the navigator of the ship to determine accurately his direction from the lightship, so that the exact position of his vessel is made known to him as soon as he approaches close enough to the lightship to receive its signals.

At a farm on the New England coast, engineers of the Bell System laboratories are quietly investigating the causes and habits of static by means of the instruments shown above. This apparatus records the strength, direction, and duration of all static discharges within its range. By studying the records, which are printed automatically, the engineers hope eventually to devise some means of eliminating static

At the same location the strength of signals received from British transmitting stations is being studied by means of the measuring instrument shown at the right. This work is preliminary to the establishment of the first commercial transatlantic radio-telephone service



First successful experiments in radio transmission and reception from a speeding express train in England were made recently on the London and Northeastern Railway by members of the Radio Society of England, who are shown above with their radio sets

For Greater Safety

THE U. S. Army Air Service recently produced an improved form of "direction finder" for use on aircraft as an important adjunct to aerial navigation. It was tried out at the experimental flying station at McCook Field, Dayton, Ohio, by Capt. W. H. Murphy and Lieut. A. J. Lyon in a De Haviland biplane.

During the experiments the new device was given a serious practical test when the plane ran unexpectedly into a dense fog. It proved its value by guiding the aviators safely back to their landing field. It will help make the airmail service and future passenger services safe, irrespective of weather conditions.

A Municipal Experiment

THE new municipal broadcasting station WNYC in New York has been compelled by circumstances to try a novel experiment. As a result of certain differences of opinion between the city and private corporations, it has been impossible to secure connecting wires to the studio of WNYC for outside concerts under the remote control system.

As a result of this situation the engineers employed by the city are experimenting with the network of wires used by the Police and Fire departments for alarm purposes. Should these experiments prove successful, a new era in broadcasting will be opened up. In fact, municipal broadcasting may well be the ultimate solution of the problem: "Who shall pay for broadcasting?"

Telephone wires actually are employed to transmit many telegraph messages simultaneously with telephone conversation. There seems to be no reason why the city's telegraph system cannot be used as a feeder to its broadcast station.

Setting Clocks by Radio

THE U. S. Bureau of Standards is experimenting with a radio clock-setting apparatus with the object of permitting the Arlington naval radio station to control automatically the clocks of the country as well as those of ships.

The main object, however, is to eliminate the necessity of radio operators changing from the universal wave length of 600 meters on which SOS signals are sent. The ships therefore will get standard time signals without any lapse in the watch that protects life at sea.

An easy way to build an attractive radio cabinet is described on page 85 of the Home Workshop Department.

How to Build a Super-Heterodyne

Part II—Intermediate Frequency Amplifier and Second Detector

By Joseph Calcaterra

An article in last month's issue told how to construct the first two units of the super-heterodyne receiver—the oscillator and first detector unit, and the two-stage audio-frequency amplifier unit. The following article tells how to complete the set.

THE intermediate frequency amplifier and second detector unit forms the middle members of the complete super-heterodyne receiver.

Figure 1 on this page shows the layout of parts for this unit, while Fig. 2 is the wiring diagram. All parts in the two illustrations are lettered with corresponding numbers and symbols that will be referred to in this article.

The new low-frequency (long - wave - length) signal that is formed in the oscillator and first detector unit by combining the oscillations produced by the local oscillator with the oscillation received by the first detector tube from the loop or aerial, is passed into the grid circuit of the first radio - frequency amplifier tube, 54, by the filter coupler. This consists of coils 51 and 52, which are so designed that they will pass the oscillation of the required frequency and will suppress undesired oscillations.

The signal then is amplified at the long wave length by a series of radio-frequency amplifier tubes and transformers and passed into the detector stage to be reduced to audio-frequency and further amplified at audio-frequencies by the audio-frequency amplifier unit.

For the sake of clarity, in referring to the various units, the oscillator and first detector unit will be called "unit 1", the intermediate frequency amplifier and second detector unit, "unit 2," and the two-stage audio-frequency amplifier unit, "unit 3." The complete set with the three units combined is shown in Fig 3.

Number 39 is the binding post connected with binding post 21 of unit 1 to complete the plate circuit of the first detector tube.

Numbers 40 and 41 are A-battery terminals connecting the A-battery circuits of unit 1 with the A-battery circuits of unit 2. Number 40 is the negative A-battery terminal, and 41 the positive A-battery terminal.

Number 42 is a standard 400-ohm potentiometer; 43, a 1-microfarad fixed condenser; 44, rheostat controlling the filament current of the three radio-frequency amplifier tubes, 54, 55, and 56; 45, rheostat controlling the filament current of the second detector tube 57.

Number 46 is the binding post which is connected with binding post number 24 of unit 3.

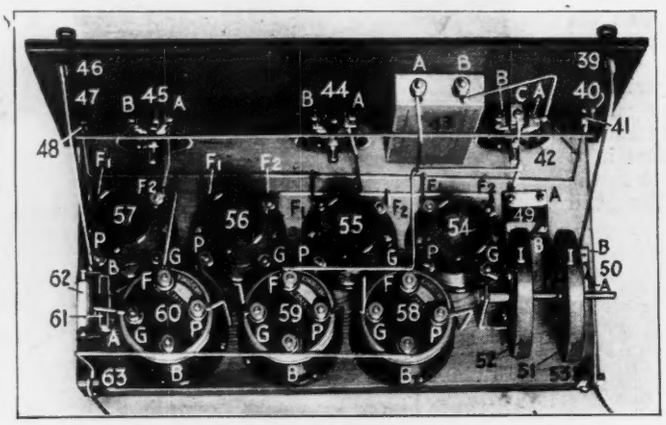


Fig. 1.—The layout of parts for the intermediate frequency amplifier and second detector unit of the super-heterodyne receiver

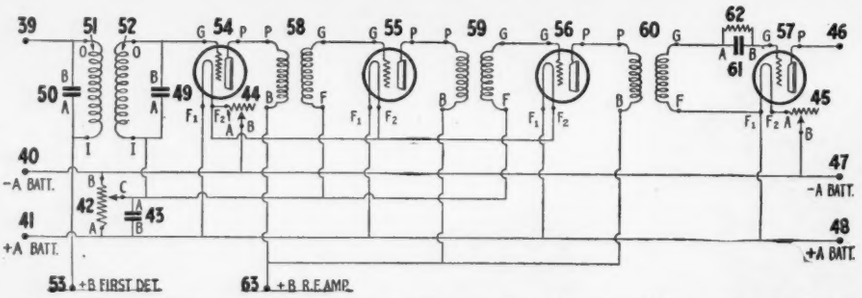


Fig. 2.—Wiring diagram for the same unit, with parts lettered and numbered correspondingly

NUMBERS 47 and 48 are the binding posts with which binding posts 25 and 26, respectively, of unit 3 are connected in order to connect the filament circuits of unit 3 with those of unit 2.

Number 47 is the negative A-battery lead terminal; 48, the positive A-battery terminal lead; 49 and 50, .00025-microfarad fixed condensers; 51, the plate coil of the filter coupler; 52, the grid coil of the filter coupler; 53, the positive B-battery terminal of the first detector; 54, the first radio-frequency amplifier tube; 55, the second radio-frequency amplifier tube, and 56, the third radio-frequency amplifier tube.

Number 57 is the second detector tube; 58, the first radio-frequency transformer; 59, second radio-frequency transformer; 60, third radio-frequency transformer; 61 a .00025-microfarad grid condenser; 62, a 2-megohm grid leak; 63, the positive B-battery terminal of the radio-frequency stages.

Begin the wiring by running a wire from terminal 41 along the top of the baseboard and in front of the *F* terminals of the sockets, to terminal 48. Then connect the F_1 terminals of the sockets with this wire by short lengths of wire. Another wire is used to connect the wire just mentioned with the *A* terminal of potentiometer 42 and the *B* terminal of condenser 43.

NEXT, run a wire from terminal 40 to terminal 47, and join the *B* terminals of rheostats 44 and 45 and the *B* terminal of potentiometer with this wire by using short lengths of wire.

Now join the F_2 terminals of sockets 54, 55, and 56, and the connecting wire with the *A* terminal of rheostat 44. The *A* terminal of rheostat 45 is connected with F_2 terminal of socket 57.

The *B* terminal of condenser 50, just visible behind coil 51, is connected with terminal 39, and the outside end, *O*, of coil 5 is joined with the connecting wire.

The *A* terminal of condenser 50 is connected with terminal 53 and the inside end, *I*, of coil 51 is joined with the connecting wire.

The *B* terminal of condenser 49 is connected with the *G* terminal of socket 54 and the outside end, *O*, of the coil 52 is joined with the connecting wire.

The next step is to suspend the grid leak and condenser in midair by connecting the *B* terminal of condenser 61 with the *G* terminal of socket 57. The *A* terminal of condenser 61 is connected with the *G* terminal of transformer 60. The grid leak, 62, is slipped into the condenser clip made to receive it.

Now connect the *P* terminal of socket 56 with the *P* terminal of transformer 60; the *P* terminal of socket 55 with the *P* terminal of transformer 59; the *P* terminal of socket 54 with the *P* terminal of transformer 58; the *G* terminal of socket 56 with the *G* terminal of transformer 59; the *G* terminal of socket 55 with the *G* terminal of transformer 58.

Fig. 3.—Complete super-heterodyne set, showing the three units combined

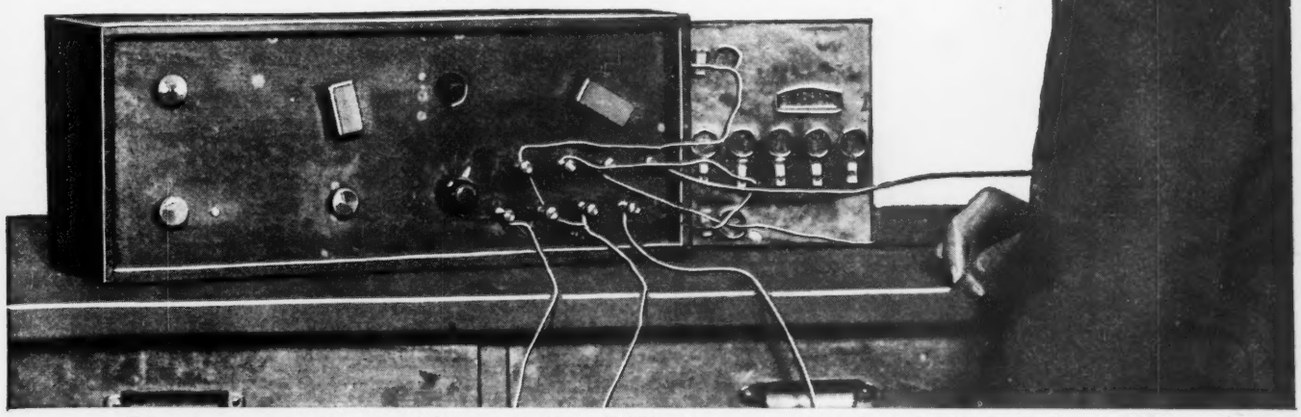
(*Continued on page 157*)

A Coast-to-Coast Radio Set Built for $15.25

By L. Grant Hector, Ph.D.

COAST-TO-COAST reception on a homemade set costing only $15.25! That statement doesn't sound reasonable; but I am doing it, and so can you. Medford, Mass., Los Angeles, Calif., Atlanta, Ga., Fort Worth, Tex.—all are within its range. And the interesting part about this set is that there isn't anything tricky or complicated about it. It is easy to build and simple to operate. There are not even any taps on the coils. The set combines utmost selectivity with great range and intensity.

Of course, if you are to build this set for $15.25, including the cost of phones, tube, and B battery, you must be willing to make most of the parts, such as condensers, and coils for loose couplers, and a variometer. In any case, you will want to do the assembling yourself. If you care to spend a little more, you can buy your coils ready wound. The phones used were of the ordinary radio type, and they were plenty good enough to bring in all the above-named stations from Cleveland, O. The panel was just a piece of thin white boxwood.



The wide-range receiving set which can be built for $15.25. It is an improved three-circuit regenerative receiver

IN THE wiring diagram at the bottom of this page, L_1 is an ordinary variometer and tunes the antenna circuit. The antenna should be one wire not longer than 125 feet, preferably about 100 feet. The lead-in comes from the end, not the middle.

Figure L_2 is an ordinary loose coupler. Notice that one end of the secondary coil is fastened to the ground end of the primary coil. This connection will eliminate about 90 per cent of the howling due to body capacity.

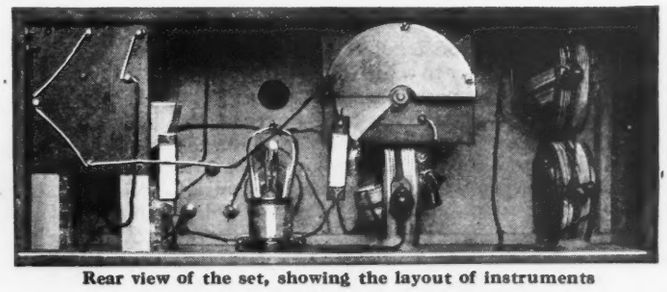
Figure L_3 is another loose coupler. Its primary is connected in series with the secondary of the first loose coupler, as shown in the diagram. The secondary of L_3 is connected in the plate circuit.

By choosing coils of the right size, it is unnecessary to have any of them tapped for the range of wave lengths now in use for broadcasting.

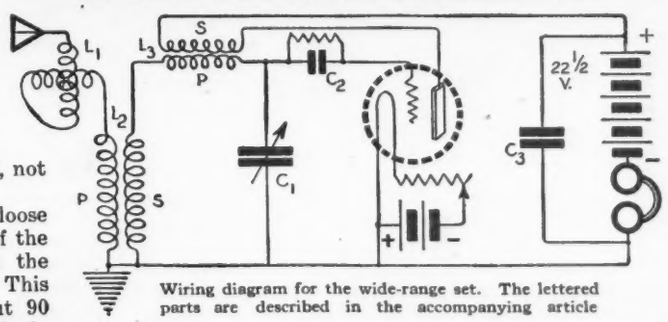
The dimension of coils and number of turns that I have used on my own set are as follows:

		Diameter	No. of Turns
L_2	P	3½ in.	14
	S	2¾ "	20
L_3	P	3½ "	30
	S	2¾ "	50

If you use ready-made loose couplers, you probably will find that they contain more turns than are required in this set, and you should remove the extra turns. If the sizes of your coils are different from those given above, you will need to use a slightly different number of turns. The larger the coil, the fewer turns required.



Rear view of the set, showing the layout of instruments



Wiring diagram for the wide-range set. The lettered parts are described in the accompanying article

Figure C_1 is a variable air condenser of about 23 plates. I made mine by cutting out half disks from a thin piece of galvanized iron. The plates are held apart by small metal washers. All the parts for the economical construction of a condenser can be bought at a ten-cent store and assembled easily if one does not wish the trouble of cutting out his own plates. The movable plates are the ones connected with the ground. This connection will further reduce the effects of body capacity.

Figure C_2 is a small fixed phone condenser. It can be made by separating two pieces of tinfoil (about ½ by 3 in. each) with a piece of paraffin paper, and wrapping the whole about a small piece of cardboard for the sake of compactness.

Figure C_3 is a similar condenser with the addition of a grid leak, which can be a piece of cardboard with a pencil mark drawn on it so as to connect the two pieces of tinfoil of the condenser. Figures C_2 and C_3 also can be purchased ready made. Expensive types are not necessary. I paid 30 cents for the two I use in my set.

NOW come the tube, socket, and rheostat. It is not practicable to try to make any of these. In attaining the remarkable range record with my set I used a soft detector tube. The new hard dry cell tubes now on the market will give almost as good results.

Practically all the tuning is done with condenser C_1. After the first adjustments have been made, you will find that the same setting of L_2 and L_3 will hold for nearly all stations, and that the adjustment of L_1 is not very critical. You can go directly from one station to another by turning C_1.

Technically, this set is a form of three-circuit regenerative receiver elaborated and improved in design.

Radio Hints for the Broadcast Fan

THE volume of sound produced by a good telephone head set is sufficient to fill a good sized room, just as a loudspeaker does, provided some device to conserve and throw out the sound is attached to the head set.

It is possible, for example, to attach the head phones to the small end of one of the large brass horns musicians play in a band. Another device sometimes employed is the attachment of the telephone diaphragm to the back of a violin, the wood of the violin acting as a sounding box.

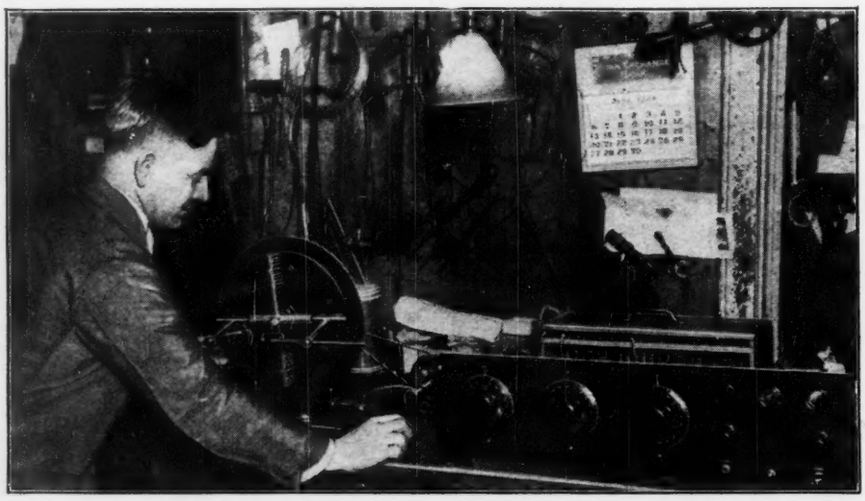
A French loudspeaker designed to be made at home consists of a cone-shaped roll of heavy paper, like a megaphone, and a small piece of hollow bamboo. The bamboo is thrust through the paper cone near its small end. The center of the bamboo carries a notch, opening inside the cone. The head phones are then placed, each against one end of the hollow bamboo tube.

The sound enters the bamboo, escapes through the notch in it and comes out through the paper cone. Even a single head phone placed against the small end of an ordinary megaphone will sometimes work quite well as a loudspeaker.

Sometimes good results are obtained simply by placing the headphones in a large bowl, a glass lamp shade, or similar object.

FOR use around an experimental hook-up, one of the most convenient accessories is a supply of the little metal clips used to fasten neckties. You can find them, too, on certain brands of suspenders.

If a piece of insulated wire is soldered to the rear of the clip and then another clip soldered to the other end of this wire, you have a convenient connector that can be clipped fast in a moment to a battery lead, a terminal, or a bus wire. The metal teeth on the business end of the clip always provide a good contact with whatever it is fastened to.

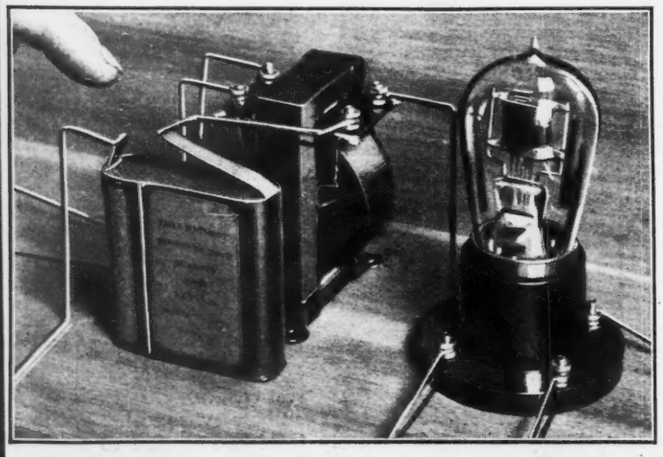


In experiments to find a way to eliminate radio's great bugbear, static, Fred Wundsam, of New York City, has perfected the static machine shown above. When the machine is operated in connection with his receiving set, the noise produced in the loudspeaker is said to resemble the roaring of a cannon. The photo shows Mr. Wundsam at his work

A HOMEMADE variable grid leak may be contrived in a few moments from an ordinary rubber band and a little powdered graphite, as, for example, some of the black lead from a soft lead-pencil shaved off and ground with a penknife blade to a fine powder.

Rub the powdered graphite well into the surface of the rubber band and then mount the band in the set so that the terminals to which it is attached can be moved apart in such a way as to stretch the band. This will increase the resistance of the grid leak; allowing the band to shorten itself will decrease the resistance. The current is carried, of course, by the thin layer of graphite on the rubber.

IT IS not generally known that almost any form of carbon, for example, either coal or coke, may be used as a crystal detector in place of galena or a similar mineral. The use of coke does not usually require readjustment of the catwhisker. A small bit of coke saturated with quicksilver is said to be even better than the coke alone.



No doubt you have heard of the radio C battery, but do you know how to hook it up to your set? The C battery is a flashlight battery, or its equivalent, placed in the negative filament lead of the transformer. The negative side of the battery is connected with the negative filament

IT IS important to handle your head phones quite as carefully as you do your vacuum tubes. Inside each head phone there is a small permanent magnet. Any shock to this magnet—dropping it or knocking the head phone against the table—will weaken the magnetism. This makes the head phone less sensitive. It can be remagnetized, however, by sending it back to the makers.

THE hard rubber or "ebonite" used for panels and coil tubes and similar purposes may be cut, bent, and worked easily if it is softened for a few minutes in hot water. The water should not be boiling, just hot enough to be uncomfortable to the hand. If it is too hot the rubber will melt altogether.

This electron vacuum tube, said to be the first ever constructed, is at the National Museum in Washington, D. C. It was made in 1898 by D. McFarlan Moore of New York. Radio waves from it were used to set off a bomb and blow up a miniature battleship Maine

IT IS a good idea to keep a running record of the number of hours that you use the batteries on your radio set, especially if you use dry batteries. Nothing is more annoying than to find that your batteries have run down just when you especially want to hear a certain program. Keep a little note-book close to your set.

For other useful radio hints, turn to page 133 in The Home Workshop. There you will find how to make a winder for preparing coils; an adjustable loop aerial, and a loop former for making radio connections.

How Broadcasting Works

The First of a Series of Articles on the A-B-C's of Radio

By Robert E. Martin

WITH this issue Popular Science Monthly presents an expanded and improved radio department. Each month nationally known experts will offer you in short, pithy, understandable form the radio information you really need to keep abreast of the times and to make the most of your outfit. It will pay you to watch this section for the latest radio news and the most timely operating and construction advice.

The readers of Popular Science Monthly are well acquainted with Robert E. Martin as a writer who knows how to interpret the technical terms of science in readable language. Beginning on this page is the first article in his series on "How Radio Works," which will give you a new and clearer understanding of broadcasting and reception.—THE EDITOR.

MOST persons who drive automobiles regularly probably have a very clear notion of "what makes the wheels go round." How many radio enthusiasts, though, know exactly what process music or speech goes through before it is heard in the head phones?

Radio is so new and apparently so complicated that the newcomer in the ranks of broadcast fans fears that its details are beyond his understanding, and so he is content merely to twirl the knobs of his set and listen in.

Now, there is no reason why this should be the case. Though the average receiving set is an immensely complicated apparatus, though a transmitting station is even more complex, the fundamentals of radio are simple. With a clear understanding of them, the satisfaction you derive from your radio set will be increased immeasurably.

Take the matter of broadcasting. When a singer performs in a broadcasting station in New York City, say, and you hear the music in Chicago, you realize, of course, that the sounds you hear are not the actual sounds that issued from the throat of the singer. You know from experience that sounds cannot travel through such an immense distance. What you hear are representations of those sounds, bearing about the same relation to them that a photograph does to the person of whom it is taken.

The music in the broadcasting studio suffers several transformations before it reaches your radio set. The original sound waves are transformed into electrical waves and then greatly strengthened—magnified—in order that they may span the great distance between the studio and your receiving set. Then, when those electrical waves reach your receiver, they are so badly spent after their long journey that they must be magnified again before they are strong enough to be converted again into sounds that you can hear.

YOU can picture the process more clearly probably, if you will compare it with sending a message to a distant friend, say 3000 miles away. Obviously you cannot speak the message to him across that distance. But you can, for example, dictate your message to a stenographer. The stenographer then transcribes it on paper with a typewriter, and dispatches it through the mail.

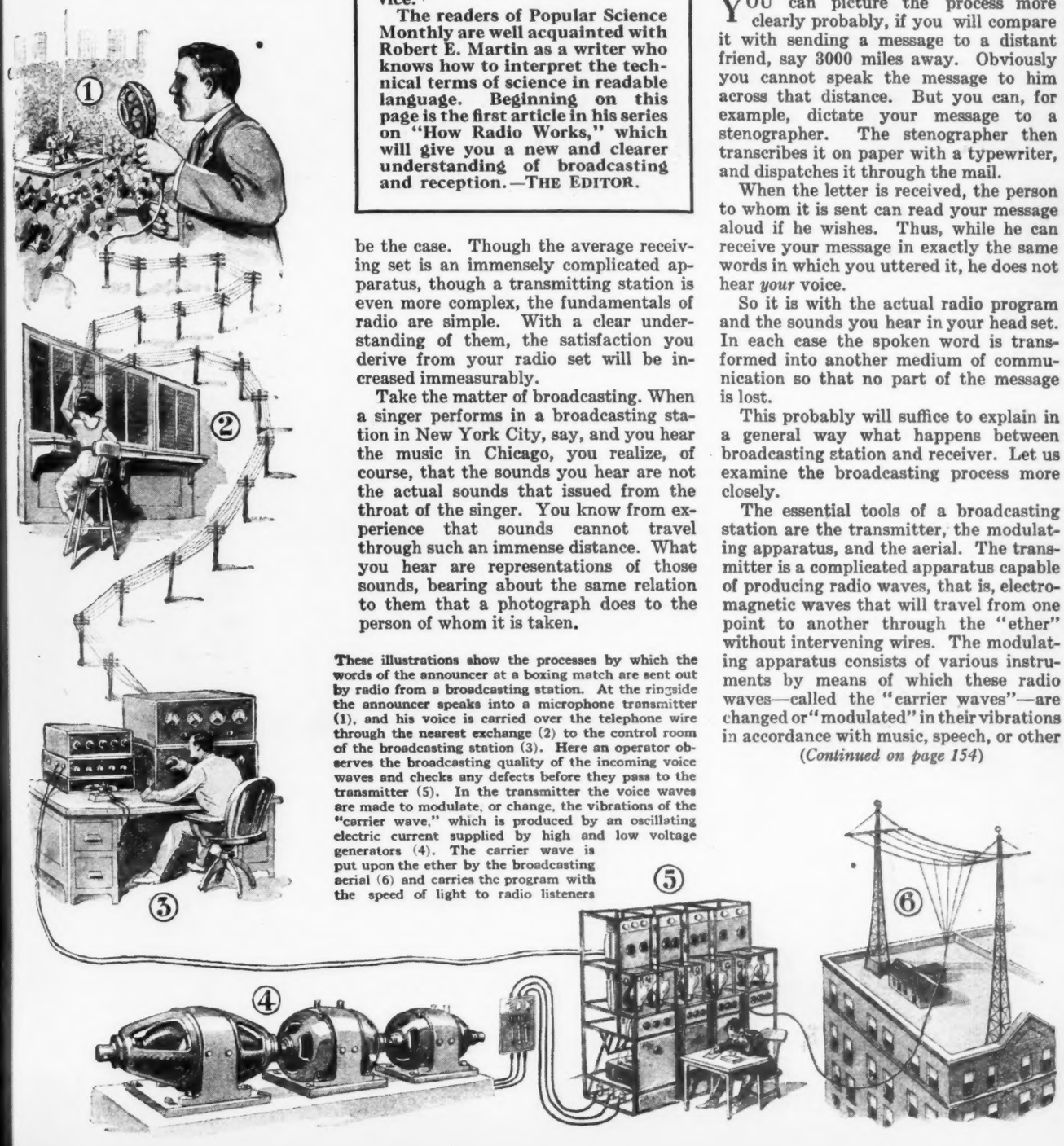
When the letter is received, the person to whom it is sent can read your message aloud if he wishes. Thus, while he can receive your message in exactly the same words in which you uttered it, he does not hear *your* voice.

So it is with the actual radio program and the sounds you hear in your head set. In each case the spoken word is transformed into another medium of communication so that no part of the message is lost.

This probably will suffice to explain in a general way what happens between broadcasting station and receiver. Let us examine the broadcasting process more closely.

The essential tools of a broadcasting station are the transmitter, the modulating apparatus, and the aerial. The transmitter is a complicated apparatus capable of producing radio waves, that is, electromagnetic waves that will travel from one point to another through the "ether" without intervening wires. The modulating apparatus consists of various instruments by means of which these radio waves—called the "carrier waves"—are changed or "modulated" in their vibrations in accordance with music, speech, or other

(*Continued on page 154*)



These illustrations show the processes by which the words of the announcer at a boxing match are sent out by radio from a broadcasting station. At the ringside the announcer speaks into a microphone transmitter (1), and his voice is carried over the telephone wire through the nearest exchange (2) to the control room of the broadcasting station (3). Here an operator observes the broadcasting quality of the incoming voice waves and checks any defects before they pass to the transmitter (5). In the transmitter the voice waves are made to modulate, or change, the vibrations of the "carrier wave," which is produced by an oscillating electric current supplied by high and low voltage generators (4). The carrier wave is put upon the ether by the broadcasting aerial (6) and carries the program with the speed of light to radio listeners

Above is a striking demonstration of how the flexible mounting of the four rear wheels permits the new six-wheel Army motor truck to ride easily over the roughest roads. Notice that two diagonally opposite wheels are passing over large blocks on the roadway without disturbing the other wheels. At the left are shown the two rear axles, with pivoted type of suspension

New Six-Wheel Army Truck Absorbs Road Shocks

IN an effort to prevent the destruction of highways by heavy motor transport, Army engineers at Camp Holabird, Md., recently have perfected an unusual new type of six-wheel cargo truck, which they claim gives the easy riding qualities and flexibility of a touring car over the roughest roads.

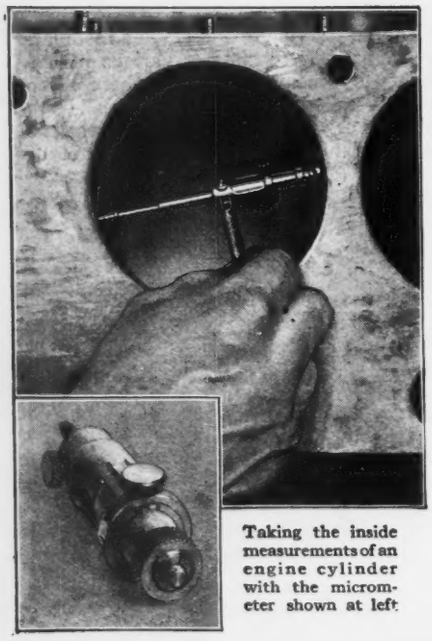
These results are said to have been obtained not only through the use of pneumatic tires on all six wheels, but through the flexible mounting of four wheels in tandem at the rear. Instead of the usual worm-driven rear axle, two double reduction axles with a flexible trunion type of suspension are employed. In other words, the two rear axles are pivoted in such a way that they move separately to conform to uneven road surfaces. Thus, one of the rear wheels passing over a large obstruction, will not jolt the body of the truck nor affect any of the other wheels. The designers claim the truck can be operated over worn-out, pot-holed macadam without the least discomfort to the driver.

Both of the rear axles are used for driving and braking. Two sets of four-wheel brakes operate on the four rear wheels. With a full five-ton load, and at a speed of 20 miles an hour, the six-wheeler can be brought to a full stop within a distance of 25 feet.

In steering tests the truck was turned in a 68-foot circle on a wet clay baseball diamond.

Inside Micrometer for Auto Repair Work

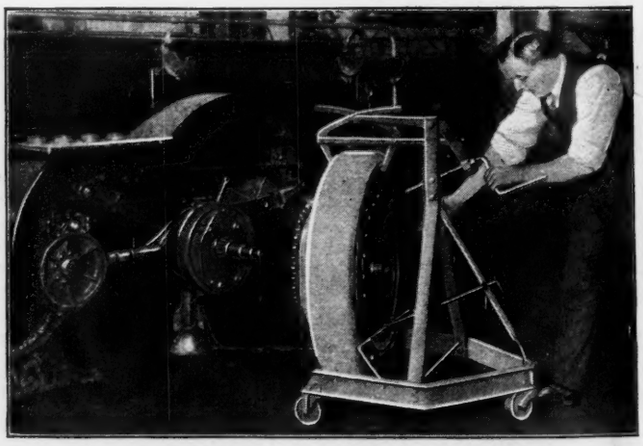
A NEW micrometer for inside measurements in automobile repair work contains a thumbscrew clamping device by which the thimble of the micrometer can be locked at any reading. The instrument has a range of measurements from two to eight inches on a scale of thousandths of an inch. For taking difficult measurements of small holes an adjustable handle is provided.



Taking the inside measurements of an engine cylinder with the micrometer shown at left

Small Crane Handles Heavy Truck Wheels

TO aid in removing and replacing heavy motor truck wheels — a task that usually requires at least two men — a small portable steel crane has been perfected for use in large garages and repair shops. One man can operate it.



One man lifting a heavy truck wheel with the crane

At the top of the crane are steel jaws, shaped like ice tongs, that grip the top of the wheel rim. These jaws are tightened or released by the turning of a hand crank, which also lowers the wheel after it has been pulled away from the axle. Stops at the base of the crank hold the wheel steady while it is being taken off or attached.

The device is mounted on iron casters so that it can be moved about easily.

Automatic Danger Signals for Cross-Roads

AUTOMATIC warning signals to prevent collisions between automobiles at dangerous cross-roads have been tested recently with reported success near Bordeaux, France.

The signals are operated electrically. Across each roadway near the intersection is placed a metal plate even with the road level. Whenever an automobile, approaching the crossing, passes over he plate, it makes an electric contact that releases a danger signal at the crossing and on the intersecting road. At night the signals are illuminated for several seconds after contact is made with the road plate.

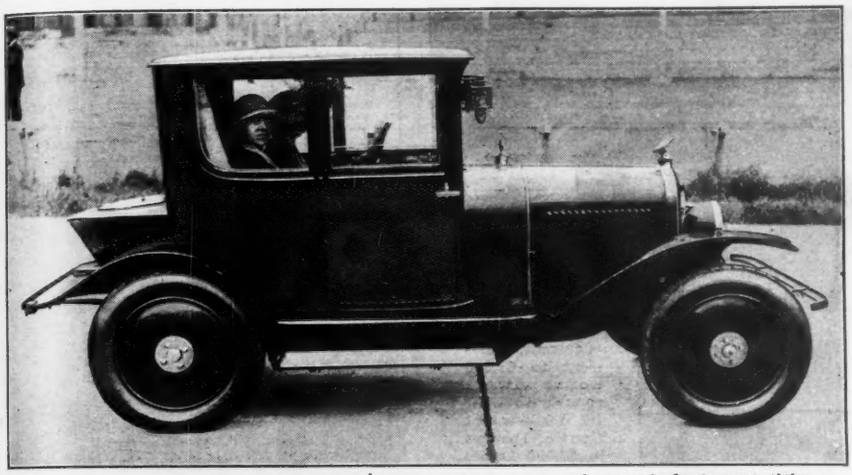
Thus a driver is warned instantly that another car is approaching the intersection. The signal is at sufficient distance from the crossing to give him time to apply his brakes. Installation of the system is said not to be costly.

American Ideas in New French Car

FOLLOWING a visit of several months in the United States, during which he made an extensive study of American methods of quantity production of automobiles, André Citroen, famous French automobile manufacturer, has developed the novel type of inexpensive car pictured here.

This car is a light coupe model of unusual lines, especially designed for the person of moderate means. With other models following the same general style, it will be manufactured and distributed in large quantities in Europe to meet an increasing demand for a car of low initial cost and upkeep.

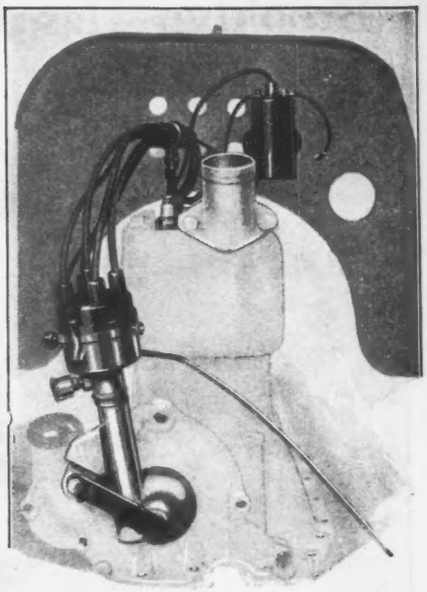
In the new venture Citroen is reported to be following Henry Ford's methods.



The new French small car which André Citroen plans to manufacture in large quantities

Rain Stains the Hood

AFTER your car has been run in a heavy rain, special attention should be given to sponging and wiping the hood. When the hood is fairly hot raindrops will stain it readily.



Complete Ignition System Designed for Fords

A COMPLETE new ignition system for Ford cars, similar to the systems used on larger cars, and replacing the usual Ford timer, has been perfected by a concern in Springfield, Mass. The accessory can be used on all Ford models, it is claimed.

Outstanding advantages claimed for the new system include automatic spark advance; big, hot sparks at low speed, insuring quick starting; scientifically accurate timing; complete ignition of gas in the cylinders; clean spark plugs and steady power.

Setting the Spark Lever

ON MOST automobile engines having spark advance, the spark lever should be set about half to three-quarters of the way to the top of the quadrant for normal driving. Thereafter the automatic advance, incorporated in the ignition system, will control the spark position.

Portable Scales Aid in Road Protection

ACCURACY, simplicity, portability, and quickness of operation are claimed for a new type of truck scales with which an inspector can weigh a truck wherever he may happen to be to determine whether it is exceeding the load limit for concrete highways, bridges, and city streets.

The device is a portable instrument weighing only 40 pounds. Two models are manufactured. One of these is a small plate on which it is necessary merely to drive the wheels of the truck. The other is designed for weighing on the jack principle. Small dial scales give a quick reading as to whether the truck is an offender in overweight or not.

One purpose of this portable apparatus is to increase the effectiveness of road protection crews. With it they can change their locations at will, whereas the locations of permanent scales soon become known to chronic offenders, making it possible for them to detour and evade the law.

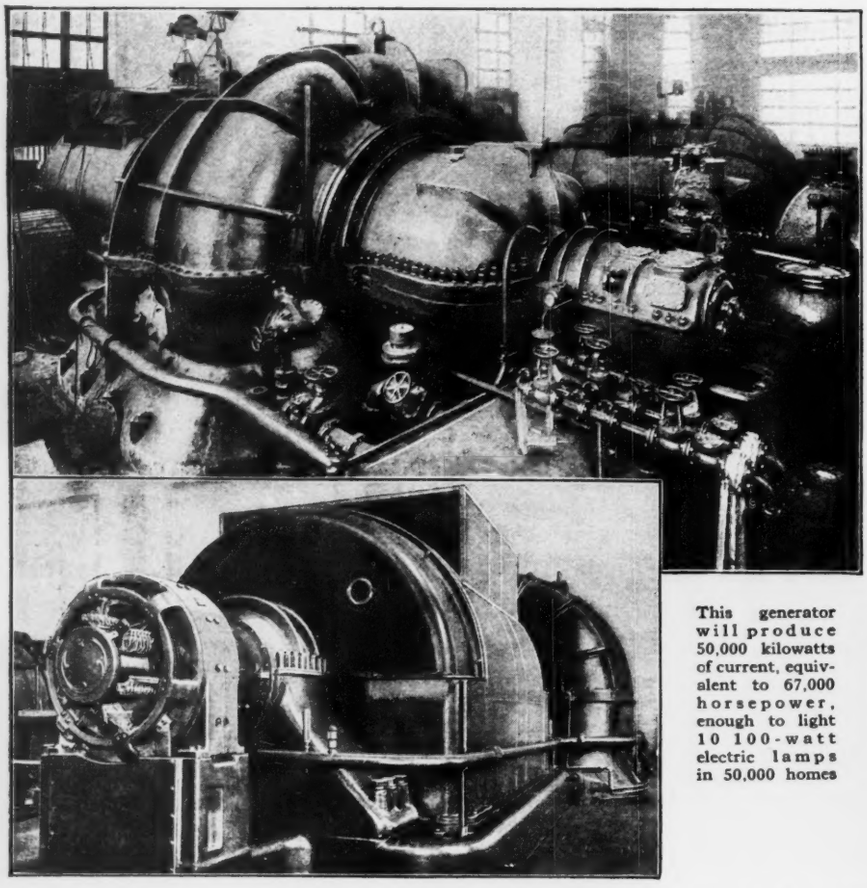
The portability of the small platform scales is shown above. A truck is weighed simply by running each of the wheels on the platform and reading the weight on a dial

Taking the Hills on "High"

TRYING to climb every hill on high gear not only may injure the engine of your car, but may result in serious accident.

Sometimes it happens that a driver, attempting to rush a hill on "high," finds, when he gets half way up that the speed of the engine is so reduced it will not accelerate sufficiently to continue climbing on low gear. Then the brakes may fail to work properly and the car backs down hill, perhaps landing in a ditch and resulting in a tragedy.

Brooklyn Has Largest Generator



This generator will produce 50,000 kilowatts of current, equivalent to 67,000 horsepower, enough to light 10 100-watt electric lamps in 50,000 homes

THE largest steam-electric generator in the world was recently put into commission in Brooklyn, N. Y. The generator was built at a cost of $1,000,000, and will generate 50,000 kilowatts of current, the equivalent of 67,000 horsepower. Within 24 hours of its complete installation it was producing at full capacity.

This generator is capable of lighting 10 100-watt lamps in 50,000 homes. Twenty million dollars is said to have been spent on the power station where two such generators were installed. It is expected that by the time the station is fully completed, a similar sum will have been expended.

Bricklaying Made Easy for the Amateur

A NEW bricklaying process is said to allow unskilled laborers to lay from six to 10 bricks a minute, or nearly 3000 a day, without previous training. The system was devised by an Englishman.

When the site of a house has been chosen and its plan arranged, uprights, preferably of angle iron, are placed in the ground at the corners and upright T-pieces are fixed between these at intervals of about 10 feet. These uprights form the building line of the house. Boards, usually 10 feet long, seven inches deep, and one inch thick, slide against the angle and T-uprights and form the face against which the bricks are laid.

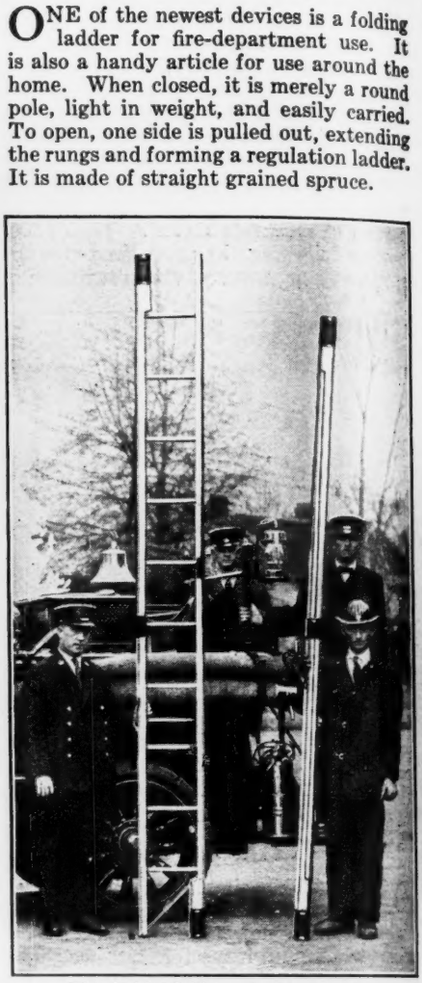
The boards are moved along as the work progresses.

Uprights and T-pieces guide the amateur bricklayer

THERE is one physician to every 724 persons in the United States. In England there is one to every 1087 persons, and in Central Europe only one doctor to every 2000 or 2500 persons.

Folding Ladder Useful in Home or Fire-House

ONE of the newest devices is a folding ladder for fire-department use. It is also a handy article for use around the home. When closed, it is merely a round pole, light in weight, and easily carried. To open, one side is pulled out, extending the rungs and forming a regulation ladder. It is made of straight grained spruce.



This ladder folds up to form a pole

A Simple Caliper that Will Give Accurate Readings

WITH the caliper shown below it is possible to obtain accurate readings at a glance concerning the exact fit of a piece of work you have on hand. It is fitted with a dial indicator with a hand that moves above or below the desired size, which is set at zero.

After the initial fitting, the caliper quickly shows whether the work in hand is under or over size and how much.

Here is a handy caliper that is easy to read, shows if work is under or over size, and how much

New Field-Glass Permits Observer's Concealment

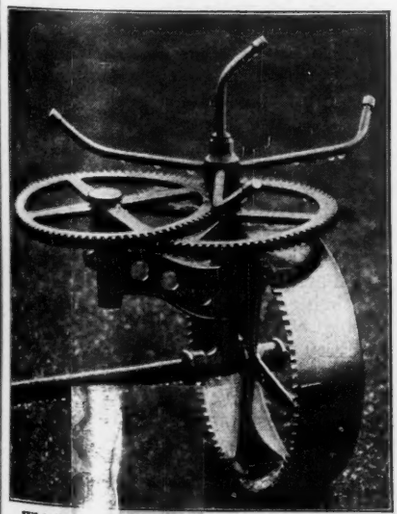
THIS new type of field-glass permits the user to sight around corners. It is an indirect-vision telescope, and allows the observer to completely conceal himself while using it. The instrument consists of a telescope with optical prisms connected with the lens so that the indirect view is obtained.

The lens is so large that it may be used in dimly lighted woods and the magnification is 10 diameters. It is of great use to naturalists.

Unseen, he stalks game with new field-glass

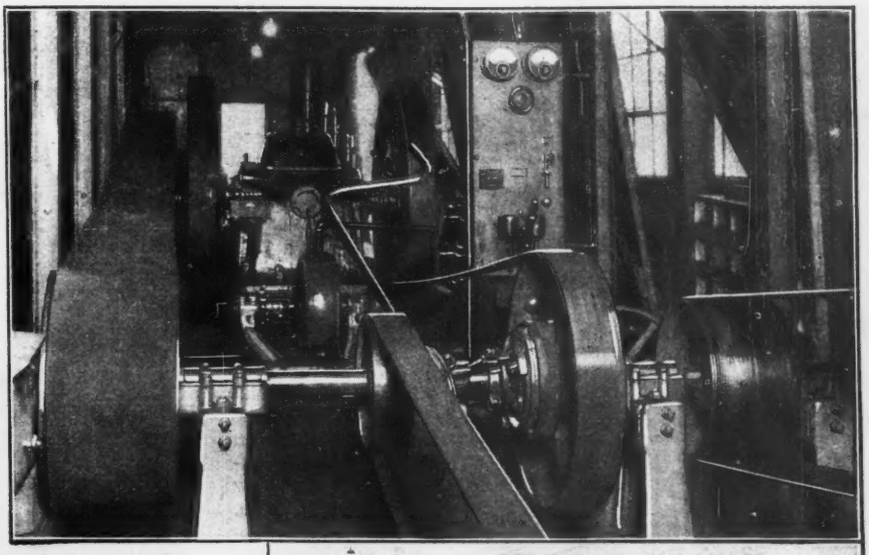
Traveling Lawn-Sprinkler Saves Much Labor

AN AUTOMATIC traveling lawn-sprinkler saves much time in watering extensive lawns. It is of the conventional whirling type. When the spiral is turned by the force of the escaping water, it moves a set of horizontal gears that are connected with a geared wheel on which the apparatus runs. Thus when the water turns the spiral, the action causes the wheel to travel over the ground radiating in a wide circle.



Whirling sprinkler travels automatically

Oil Refinery Travels on Railway Cars



Above: Interior of the traveling oil-refinery. Built on two railway cars, it can travel from place to place, as necessity demands. At right: Outside the movable refinery. It can be set up in 10 days, and packed for moving in a week

SOMETHING new in oil refineries is one built on wheels, recently put into operation in Texas. Being constructed on two large special railway cars, it may be moved to any desired location. The refinery is known as a "topping plant" and may be in complete operation 10 days after arrival at a new location and packed up for moving again in a week. Forced air draft for combustion is supplied by a suction fan nearly six feet in diameter. One of the features is the condensation of vapor with cool air instead of water, this being done by the huge suction fan.

The refinery is electrically operated throughout. An electric generator operated by an oil engine furnishes power for the pumps and current for the lighting plant.

The starting power for this large engine is furnished by compressed air, this being supplied by a two-horsepower gas engine. The refinery has a capacity of from 1000 to 3500 barrels of crude oil in 24 hours.

The special cars are jacked up and placed on concrete foundations while the plant is in operation and two men to the shift can operate the plant.

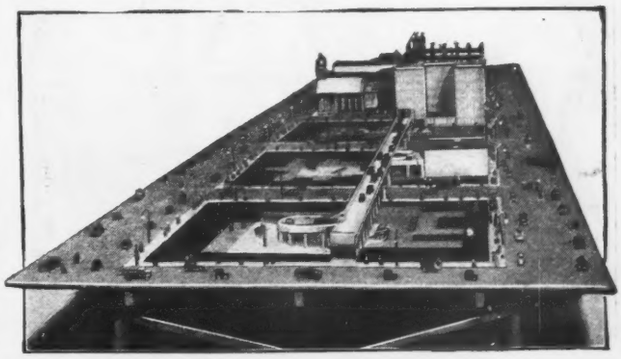
Concrete Viaducts Planned for Traffic Relief

EMBODIED in the ambitious model pictured below is a proposal to relieve the thickening traffic congestion in very large cities.

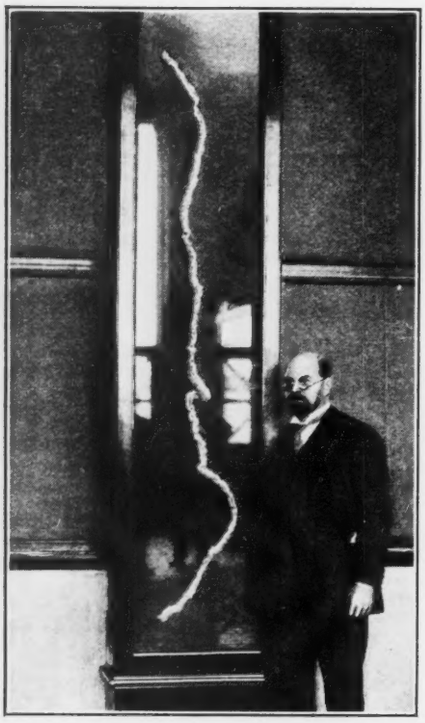
This proposal contemplates the construction of concrete viaducts cutting through the centers of the lines of blocks between the congested streets, where traffic is largely on streets running in one direction. The alleyways under these viaducts could serve for deliveries, refuse collection, and more ready access for the fire department. At suitable intervals, curving descents would be provided.

It is declared that the cost of constructing these viaducts, even when they must pierce buildings, would prove surprisingly low.

SAN FRANCISCO has fewer thunderstorms than anywhere in the United States, according to 20-year records compiled by W. H. Alexander, of the U. S. Weather Bureau. Tampa, Fla., has more thunderstorms than any other part of the country. Another bad spot is Santa Fé, N. M., where 1456 storms occurred in 20 years.



Man Captures Lightning in the Sand Dunes



IT REMAINED for Dr. Henry W. Nichols of the Field Museum of Natural History of Chicago to surpass the ancient deities by subduing lightning so thoroughly that he can place it in cement molds.

Doctor Nichols' "lightning," however, is "petrified." It consists of an irregular hollow tube of silicate made by a flash of lightning that has sunk itself in a sand dune. When lightning hits a sand bank, the heat is so great as to melt the sand in the path of the electric discharge. A repellent current causes each particle to fly off from the others, leaving the path of the streak hollow. The translucent crust forms about the hollow tube in the sand bed, leaving the record of the flash. Sometimes little edges of this tube stick above the sand. Some tubes as long as eight feet have been uncovered.

Stories Revealed by Earth Strata

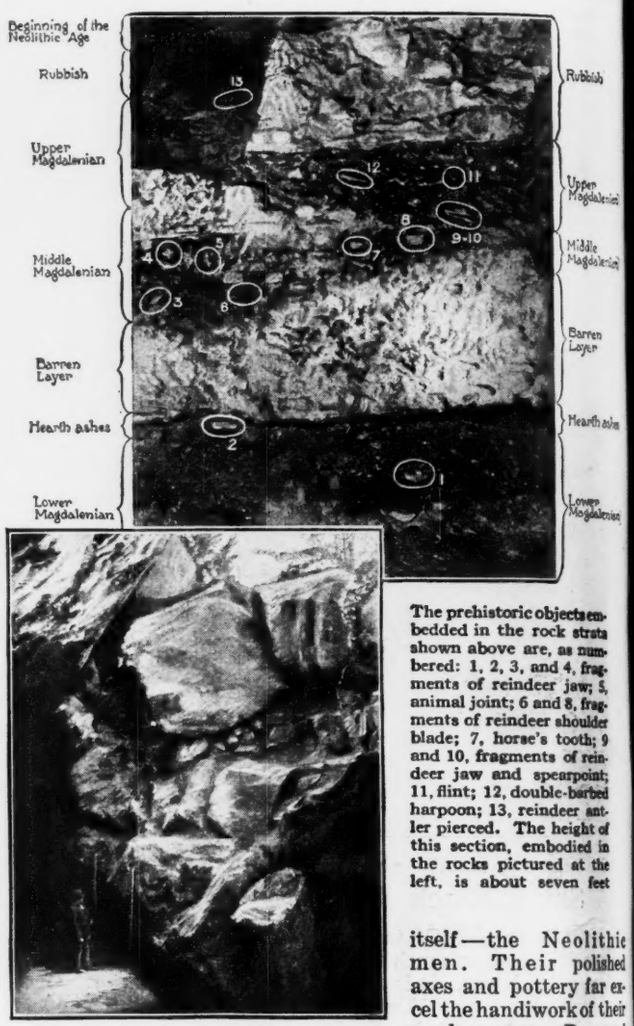
A STORY that began 15,000 years ago, far back in those dim times before men emerged from the shadows of prehistory, is written in these earth strata. They were found at Laugerie Basse, France, on a spot where, ages ago, primitive men encamped often and in great numbers. A huge, overhanging cliff that gave shelter, and a stream, probably attracted them.

The oldest stratum contains the residue of hearth fires, for those ancient men knew many uses of fire. A few crudely engraved objects are mixed with the char and ashes. Then an empty stratum occurs. During the period of its formation evidently the encampment was not used. Possibly a great migration emptied the region, the emigrants lured by tales of teeming hunting grounds elsewhere.

The next stratum reveals that the returned men had achieved a higher civilization during their absence. A sculptured reindeer head, amulets, and other proofs that art had been born, were found. So too were flint graving tools.

In the next stratum, fine, barbed harpoons appear. More and better carvings on animal bones were left here.

Then for nearly 3000 years no human traces are left. A thick layer of natural rubbish overlays the older records of progress. Then a new race established itself—the Neolithic men. Their polished axes and pottery far excel the handiwork of their predecessors. Dog and pig bones reveal probable domestication of these animals. A crude but sturdy civilization had arrived. Shortly after this period, the record ends.



The prehistoric objects embedded in the rock strata shown above are, as numbered: 1, 2, 3, and 4, fragments of reindeer jaw; 5, animal joint; 6 and 8, fragments of reindeer shoulder blade; 7, horse's tooth; 9 and 10, fragments of reindeer jaw and spearpoint; 11, flint; 12, double-barbed harpoon; 13, reindeer antler pierced. The height of this section, embodied in the rocks pictured at the left, is about seven feet

Deaf children learn cheerfully and quickly by the use of radio

Deaf Children Taught by the Aid of Radio

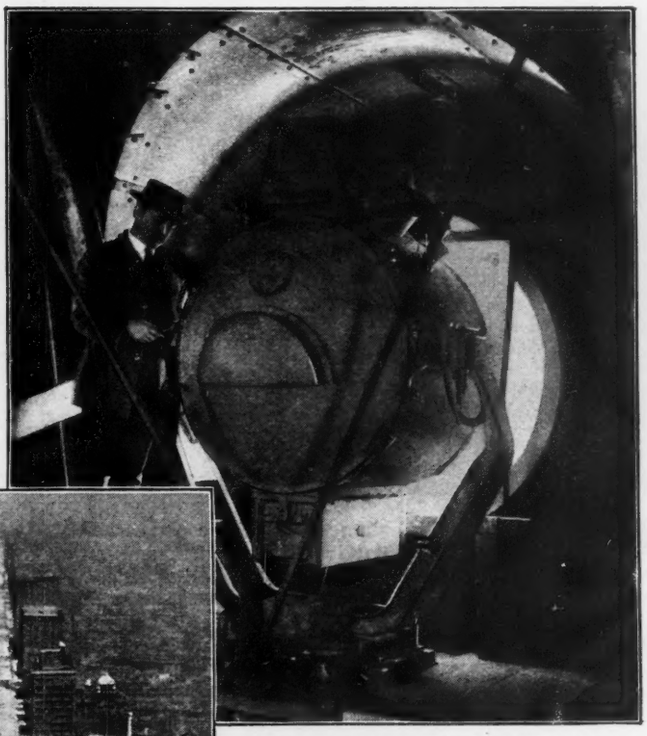
RADIO is now being used for the teaching of deaf children in the Institution for the Improved Instruction of Deaf Mutes in New York City. By means of an elaborate and unique radio system that now is a permanent part of the institution's equipment, wonderful results have been accomplished.

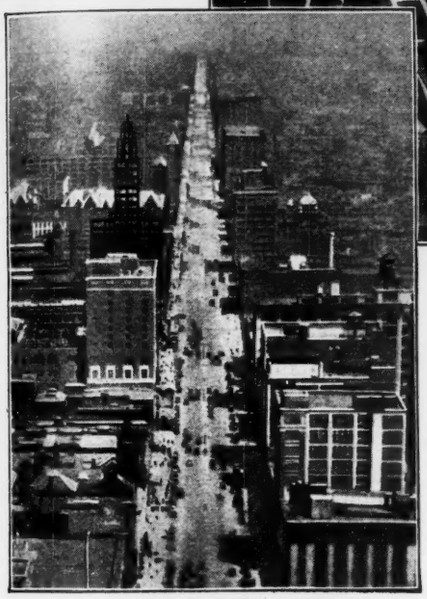
Each child has a pair of head phones, which are plugged into a jack in the table, this being connected with a master receiving set in another part of the building. As every child's hearing is different, the various head sets are regulated by means of resistances in the table to give different intensities, corresponding to the amount of the child's deafness.

Officials of the institution have found that radio opens up a new field for the successful treatment of deaf mutes and stimulates their interest and hearing.

Philadelphia's New Giant Traffic Light

TO AID in handling traffic, the City of Philadelphia has installed an enormous searchlight of 300,000,000 candlepower in the tower of the City Hall. There it commands Broad Street, which runs for a distance of 12 miles, one of the longest straight streets in the world, controlling straight-ahead and cross-town traffic by its signaling beams. The light is 30 inches in diameter.



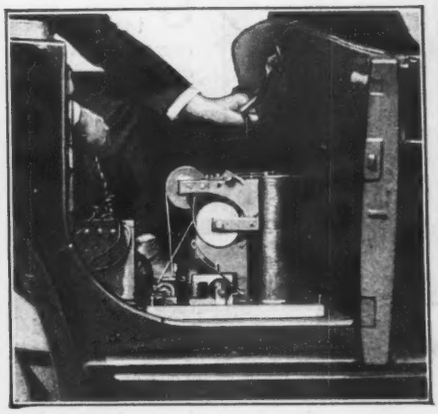


Above: Operating the giant searchlight from the tower of City Hall, Philadelphia, to signal traffic on Broad Street, shown at left

Testing Waterproof Paper

WATERPROOF papers now are tested by means of ground glass. The paper is folded into a small box filled with water, and placed on the glass. The glass rests on a dark surface with the ground side uppermost. If moisture goes through the paper, it makes that part of the glass transparent, producing a dark contrast.

U. S. Perfects Instrument to Test Brakes



THE United States Bureau of Standards has perfected a device known as a "recording decelerometer" for accurately measuring the braking ability of automobiles.

In the past, such brake tests were made by measuring the stopping distance on a road, determined by a line at which the operator applied his brakes and the final position of the car. This method led to inaccuracies.

The new method consists of mounting a weight on the end of a stiff, flat spring, and connecting this weight with a pen recorder. The action of the instrument exactly parallels that of a passenger, in that when the car is retarded, the weight tends to continue in the original direction. The more violent the retarding force, the greater the movement of the weight.

Tests with the new instrument indicate that deceleration is practically independent of speed; that a *clean* wet street is no more slippery than a dry one, and that four-wheel brakes are apt to be more than twice as effective as rear-wheel brakes alone.

America Has a Monopoly on Severe Tornadoes

TORNADOES, such as the one that left a path of death and destruction in northern Ohio this summer, are practically an American product, according to Dr. W. J. Humphreys of the U. S. Weather Bureau. This type of storm is very rare in other parts of the world.

The middle Mississippi Valley is the region where they are most prevalent. They are very rare in and east of the Appalachian Mountains, but are known in every other part of the country east of the Rocky Mountains.

The exact conditions productive of tornadoes are not known. It has been observed, however, that they most frequently occur in the southeastern part of large circular storms.

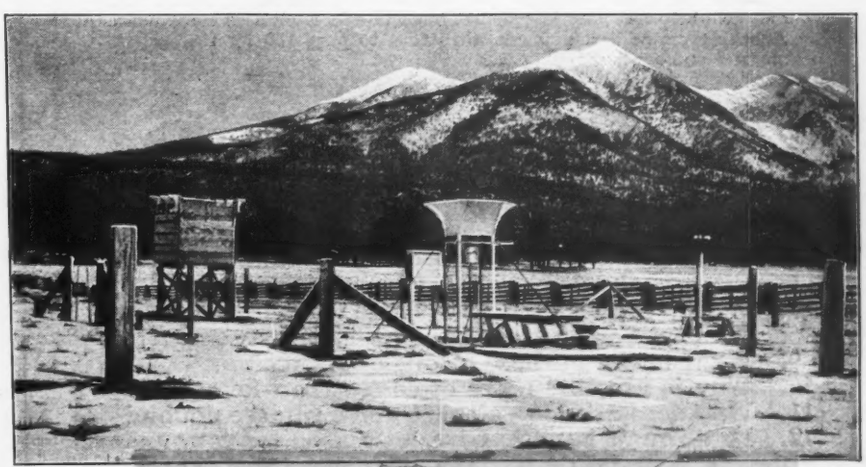
Just as cross currents produce whirlpools in swiftly moving water, so tornadoes are produced by cross currents of wind. The waterspout observed over Lake Erie during the Ohio storm was merely the tornado passing over the water. The only difference between a waterspout and a Kansas twister is that the whirling winds are passing over water instead of land.

Why Forest "Openings" Remain Treeless

THE United States Forest Service has been conducting tests to ascertain why trees don't grow in the grassy openings in the midst of excellent pine forests in southeastern United States.

It was found that the fine soil deposited from neighboring elevations remains saturated with water until late in the spring, causing the seed to rot before germinating, or the seedlings to "drown" for lack of air. Should seeds get started, they perish later in the summer, when the soil bakes exceedingly hard and there is no available moisture for the roots.

These open areas also are exposed to the full sweep of the winds.



A treeless opening in the midst of pine forests, showing government soil-testing apparatus

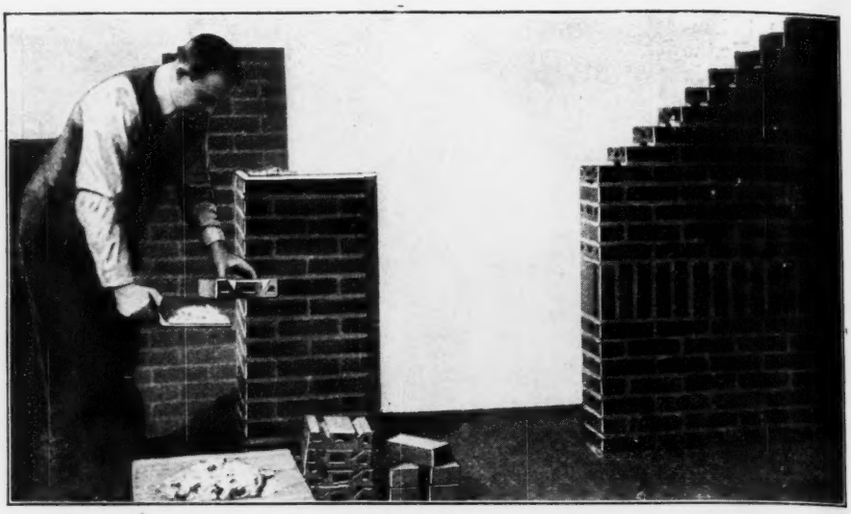
Collapsible Scissors Fit in Pocket Case

The scissors in use

OF ALL the tools that come into everyday use, few are more serviceable than scissors. Probably the chief reason why more people do not carry scissors about with them as they do pocket knives is that usually there is no shield for the blades and sharp points. To meet this need, collapsible scissors, which, when folded flat, fit into a small metal tube, recently have been invented. Even the loop handles for the fingers are collapsible.

The carrying case is fitted with a small ring so that it can be attached to a chain. It can be carried, conveniently, in a man's pocket or a woman's hand bag.

New Insulating Brick Saves Costs



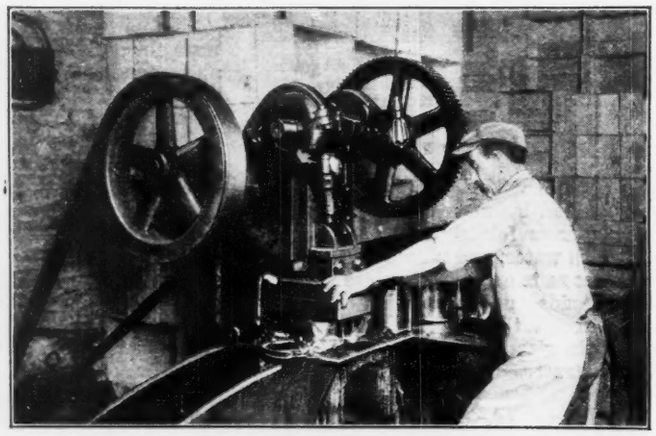
TO SAVE costs of hauling, and of mortar, a new combination brick recently placed on the market is designed to serve both as a face brick and a common brick. It has a facing on one side and an unfinished surface on the other side.

It is said to weigh only seven-tenths as much as the brick it replaces, thus saving freight and truckage costs. Its makers claim also that less mortar is required to lay it.

Efficient insulation against heat and cold is provided by two horizontal dead air cells and a central closed air cell. The brick is of the Standard size.

Pie-Maker Turns Tin Cans Into Profit

A CHICAGO pie manufacturer has turned waste into profit by the perfection of this electric machine that flattens used fruit cans so that they can be sold in carload lots for the manufacture of window weights. The cans are mashed by a heavy weight that is raised and dropped by means of gears.



How Much Science Do You Know?

EVERY day, whether you realize it or not, science is lightening and making more effective the daily labors of all of us. In the home, in the office, in the factory and workshop, a working knowledge of the principles by which science can be usefully applied is becoming more and more important to our success.

Below are a dozen simple questions about scientific facts that not only will help test your knowledge, but will afford you real enjoyment. Answer them as best you can, then turn to page 159 for the correct answers and see how nearly you were right.

Another test of 12 questions will appear next month.

1. How many muscles are there in the human body?
2. What is our solar system? How many planets are there?
3. What are electrons and what is electric current?
4. Why do soldiers break step when crossing a bridge?
5. Do we get a pound of ice from a pound of water?
6. What is the difference between soil and rock?
7. Why is copper used for electric wires instead of iron?
8. What is horsepower in scientific measurement?
9. What is the purpose of our eyelashes?
10. Why is gasoline more explosive than kerosene?
11. Why does drinking alcohol make you see double?
12. Do animals laugh? Give the reason for your answer.

Sewing-Machine Case and Table Combined

TO PROVIDE a substantial base for the portable electric sewing-machine while serving as a decorative article of furniture, a collapsible sewing-machine table has been devised.

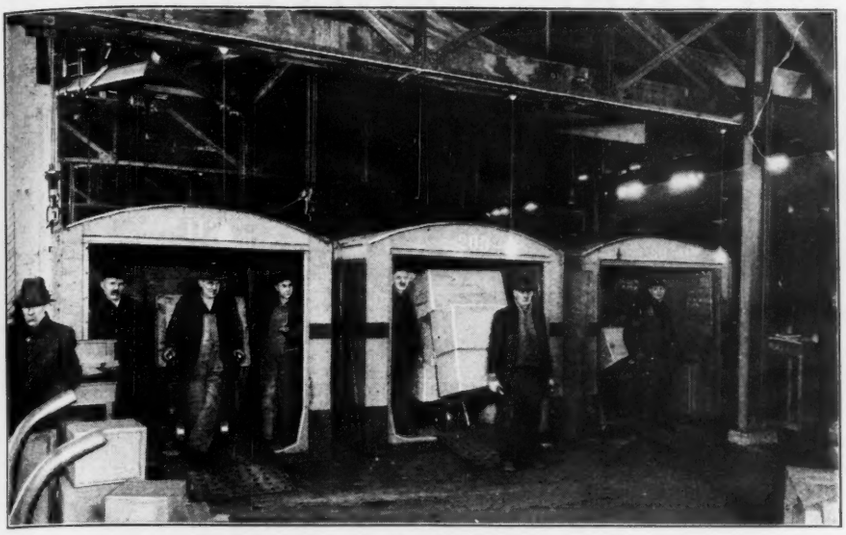
When open, the machine is held rigid at the most convenient height for sewing, and the leaves form a handy sewing-table. When closed, it has the appearance of a small cabinet, and serves as an attractive case for the machine.

How the sewing-machine table appears when unfolded

Send for List of Approved Products

POPULAR SCIENCE MONTHLY will be glad to furnish, upon request, a list of radio and tool manufacturers whose products have been tested and approved by the Popular Science Institute of Standards.

Demountable Bodies Save Freight Charges



TO ELIMINATE a great deal of expensive handling of freight shipments in less than carload lots an efficient system was recently introduced in Cleveland, Ohio, by using demountable freight bodies of moderate size. These were distributed to freight houses throughout the city, each one having a certain route to take in going from one station to another.

When the boxes were filled they were loaded on trucks provided for this purpose. These then transported the bodies to their proper freight stations, where the contents then were unloaded directly into proper freight cars with a minimum of labor. The new system resulted in a saving of much space in the freight houses, as well as a lessening of switching of freight cars, which was done away with by truck transportation.

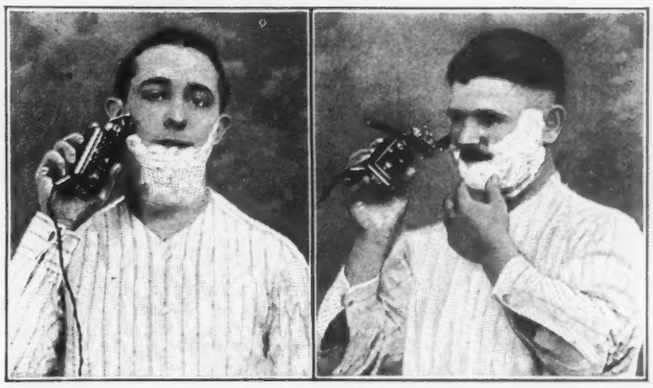
The photograph above shows workmen unloading boxes from three of the demountable freight bodies after they have been hauled to the freight station.

Pocket Pruning-Shears Is Useful Gardening Tool

POCKET pruners for trees and shrubs form a very convenient gardening implement. The metal handles are collapsible and the blades fold back into the handles when not in use, so that the closed article resembles a penknife that slips easily into the pocket. For all its light weight, the implement is sufficiently strong.

WHY are some woods more durable than others? That question is answered by investigators at the Forest Service laboratory at Madison, Wis. They find that woods that last contain substances that when extracted by water are poisonous to the forms of bacteria and wood-destroying fungi responsible for wood decay. These toxic substances are more abundant in the heartwood than in the sapwood.

Attachment Gives Electric Shave and Massage



A SMOOTH and non-irritating shave is the advantage claimed for a mechanical attachment that transforms either a safety or straight-edge blade into an electric razor that makes the blade vibrate. By inserting a massage attachment the instrument also can be used as a vibrator.

Miniature Clothesbrush Fits Pocket or Bag

A TINY clothesbrush is a novelty that will be found very useful. It fits in any pocket or small handbag and serves as an excellent article for removing dust and dirt in an emergency, especially when traveling.

A small case is provided to keep the bristles of the brush in good order and to protect them from dust and dirt.

Know Your Car

When the Clutch Sticks

ONCE in a while the clutch on your car will refuse to disengage. This trouble, which may have serious consequences in crowded traffic, is commonly known as "sticking." In a cone clutch it is usually caused by abuse of the mechanism; in a multiple disk clutch it is often due to the fact that the oil supply has been neglected or that the oil has become congealed.

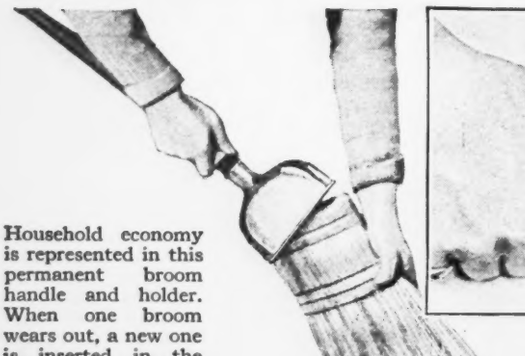
To remedy the condition, do not try to throw out the clutch by force, but throw your gearshaft lever into neutral position and coast to a stop at the side of the road. If the clutch is of the cone type, it will soon release itself, after its leather surface cools off. If it is a multiple disk clutch, the application of kerosene or gasoline will limber it up. Kerosene is preferable.

If, in a cone clutch, relining is necessary, new lining obtained from the manufacturers of the clutch is preferable, because of convenience and accuracy. If not obtainable, however, new lining should be cut, using the old as a pattern. It should be much thicker than the old lining.

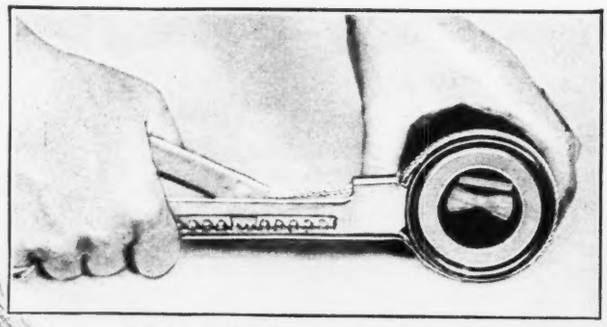
In putting on new leather lining, it is important to see that it fits tightly and true to the cone. Neatsfoot oil should be applied frequently to the new leather while it is being worked in.

In a disk clutch, if the plates are not too badly worn, they may be refaced; otherwise new plates will have to be installed. If the disks are sprung or grooved, new ones will be necessary, and they should be obtained from the manufacturers of your car.

Useful Ideas for Home Convenience



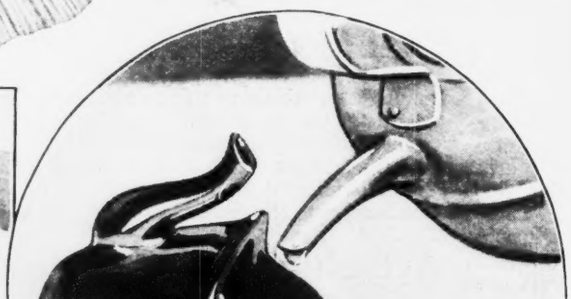
Household economy is represented in this permanent broom handle and holder. When one broom wears out, a new one is inserted in the holder and fastened



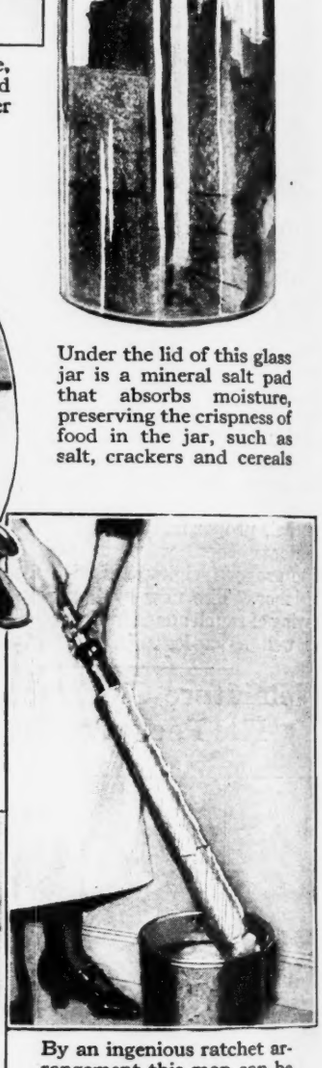
A labor-saving jar opener consists of a cable, latch, and cog handle. The cable is placed around the cover and tension applied by lever

Under the lid of this glass jar is a mineral salt pad that absorbs moisture, preserving the crispness of food in the jar, such as salt, crackers and cereals

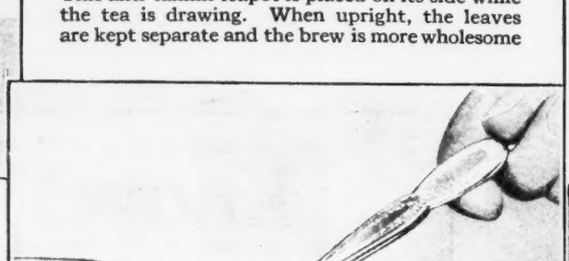
A collapsible jelly bag is held by a metal rim supported on four folding legs that fit over the edge of the kettle



This anti-tannin teapot is placed on its side while the tea is drawing. When upright, the leaves are kept separate and the brew is more wholesome

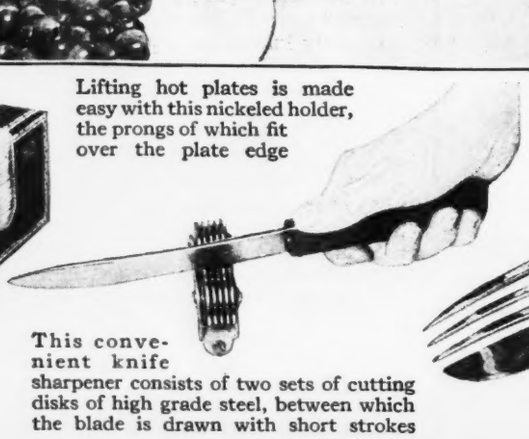


By an ingenious ratchet arrangement this mop can be wrung simply by pressing a button and turning the handle. When button is released, the mop unwinds

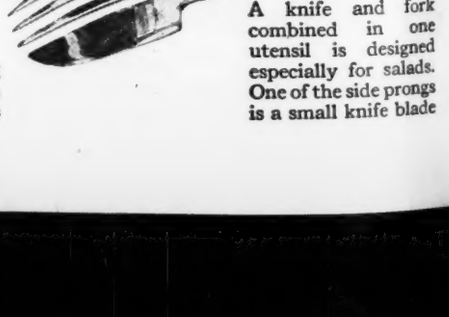


Lifting hot plates is made easy with this nickeled holder, the prongs of which fit over the plate edge

To prevent waste and assure cleanliness, paper napkins now are marketed in hygienic cardboard containers, from which the napkins may be withdrawn one at a time, either folded or unfolded, as desired



This convenient knife sharpener consists of two sets of cutting disks of high grade steel, between which the blade is drawn with short strokes



A knife and fork combined in one utensil is designed especially for salads. One of the side prongs is a small knife blade

You Can Save Your Wife 10,000 Steps a Day

By L. Porter Moore

As president of the Home Owners' Institute, Mr. Moore has helped plan thousands of small homes. His is valuable "inside advice" for the thousands of American families who want economical and attractive homes of their own.

A FEW weeks ago I asked a real estate dealer in suburban homes why most of our American houses now were being built much smaller and more compact than they used to be, and usually on little plots.

"Is it due entirely to higher costs and increasing land values?" I inquired of this operator who last year sold homes valued at upwards of $5,000,000.

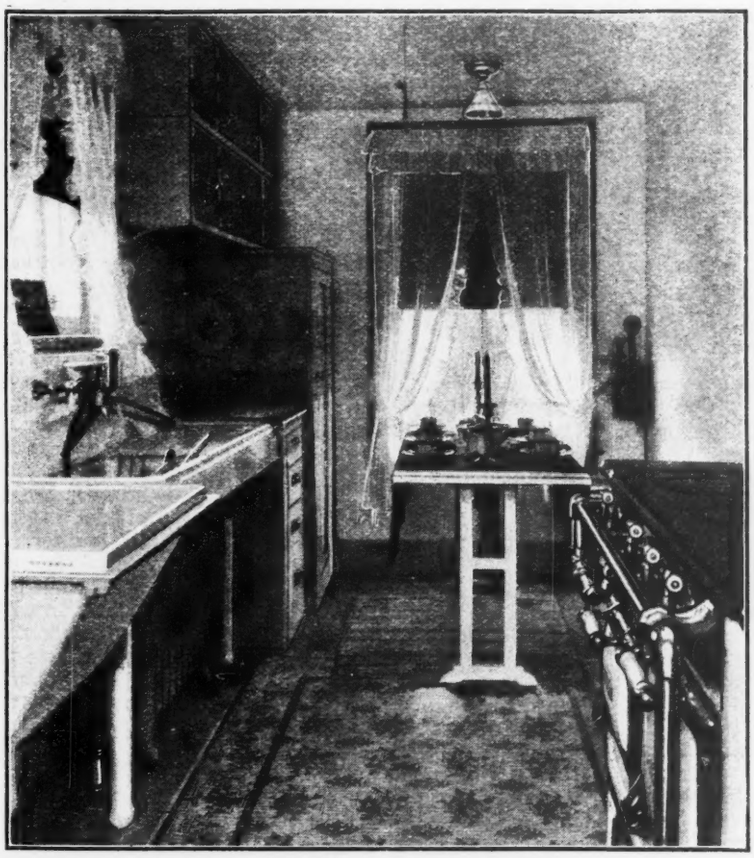
"Higher costs are playing their part," he acknowledged, "but really the most important factor, I believe is the closer application of science to building, especially in the matter of built-in features to take the place of furniture.

"Built-in furniture and labor-saving devices, worked into the house in their proper places by good architectural planning, conserve space. Houses are being made smaller, partly in consequence. Less land is used because the automobile has brought the world to our doorstep."

I HAVE always advocated compactness and mechanical efficiency in the home, and was glad to find such strong support from a realty man whose business success proves he knows what the average man and his wife want in a new home.

What he said about compactness expresses briefly the trend of progress in American home building. And nowhere is this development more marked than in the modern kitchen. Built-in devices that save time, steps, and labor have done a lot to solve the servant problem and to enable the woman of the house to take her proper share of recreation. Her work today is completed in about half the time and with far less physical exertion than that of our mothers and grandmothers. Husband and wife and children benefit.

The predominant kitchen features today are the built-in kitchen cabinet, broom closet, dresser, ironing board and breakfast nook. Other smaller built-in units include dish cupboards, cabinet over the sink, and plate and cereal warmer over the cook stove. Catalogues of the makers of better-class woodwork have made it possible to replace special designs with stock material, thus bringing the cost of obtaining the ideal kitchen within almost everyone's means.



A compact, convenient kitchen such as this might save your wife as much as three miles of walking a day. The many cupboards and the breakfast table are stock millwork of the built-in type. Sink, radiator, laundry tubs, and range are properly located for the best "routing" of the work to save steps and labor. Notice the telephone in the corner for ordering supplies

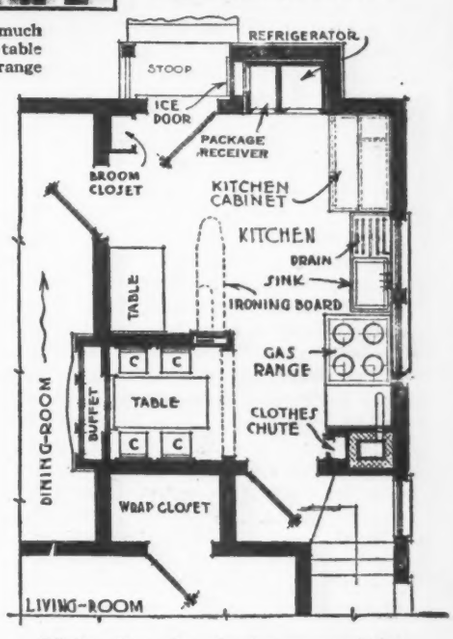
The importance of the kitchen in the modern home was indicated in a recent nation-wide house-planning contest. No two of the 6,000 plans submitted were identical. Nevertheless all of the amateur planners agreed on the fundamentals of an ideal home, and chief among these was a good kitchen. The kitchen, said the judges' report, was "the most carefully studied" part of each plan, although the majority of contestants planned poorly. This contest indicated that while home builders today realize that scientific use of space in the kitchen makes a more livable home, most of them do not realize how to plan the details on paper.

FROM a special study of houses costing from $5,000 upward, I know that there are literally hundreds of opportunities for errors in arranging and equipping a house. I know that scant consideration is given to these details, usually, until the planning is well along, and frequently, not before construction is under way.

Then the "extras" begin. When a man plans a house, without consulting a woman, its interior arrangement is likely to be anything but scientific, or attractive. And without the assistance of a competent architect, or at least good architectural plans to begin with, both the man and the woman usually make a mess of many of the details.

BY "extras" I mean the charges that begin to mount up against the home builder when the building contractor is called upon to make this or that alteration, or add details such as closets, built-in ironing board, garbage incinerator, package receiver, or electric outlets. Frequently several hundred dollars is added to the contract price for extras, because the details were not thought out carefully, put into the plans, and contracted for.

Yet most of the mistakes in planning can be avoided. Thousands of steps—perhaps 10,000 a



Kitchen floor plan, showing an astonishing number of conveniences built into small space

The dining nook for breakfast and other informal meals is one of the most popular of all the improvements of the modern kitchen, for it saves many an unnecessary step for the housewife. The use of stock woodwork makes it comparatively inexpensive to construct

day—can be saved for the woman of the house, and actually years added to her life, by proper planning at no greater first cost. After the house has been built, some mistakes can be corrected easily, and cheaply. Others can be remedied only at an almost prohibitive cost.

IN the preparation of three meals and performing the regular duties of housekeeping in a poorly-planned six or seven room house, a woman averages more than 27,000 steps in the average day. That totals about eight miles!

It has been determined that 76 per cent of those steps are in the kitchen. A well arranged kitchen, then, would be likely to save a woman a three-mile walk daily, for experiments have indicated that rearrangement of kitchen equipment, dining room, and hallways of the poorly-planned house reduces the housekeeper's walk by two-thirds for the same amount of work.

In planning the arrangement of fixtures and equipment in a kitchen, the work incident to preparing meals first should be "routed." This means that before-meal work must travel along a definite, well ordered path. Poor location of the stove, sink, the outside-icing refrigerator, the package receiver, and various cabinets may spoil the convenience of the whole workroom.

In this mapping out the work-room, the individualities of the housewife for whom it is prepared are an important consideration. Some months ago a young real estate salesman came into my office, bemoaning the results of his day of ineffectual sales efforts.

"Of all the luck!" he ejaculated. "Why did she have to be left-handed."

"What did that have to do with your losing a sale?" I asked him.

"We didn't have a house on the property equipped for a left-handed woman," he explained. "Everything in the kitchen—gas range, sink drainboard, built-in ironing board cabinets—was located all wrong. In addition, this woman was taller than the average and the regulation 34-inch sink was too low. Of course, we could have put in another sink and changed around some of the equipment, but she found another house which pleased her almost as much as one of ours, and which had been built for a left-handed housekeeper."

Often mechanical details of a house must be altered to fit particular cases. The woman's height must be considered when the kitchen sink is ordered. The best position for the sink, by the way, is under a window, with drainboards and cupboards preferably at both sides. The space below the sink should be left open, to provide access for the plumber when repairs are needed.

In planning the location of the basement steps, be sure they are handy from within as well as from without, so that furnace ashes, laundered clothes, screens or storm sash, need not be dragged through the kitchen. If the grade entry is large enough, it often affords a convenient location for the refrigerator. At any rate have the refrigerator iced from the outside, if possible.

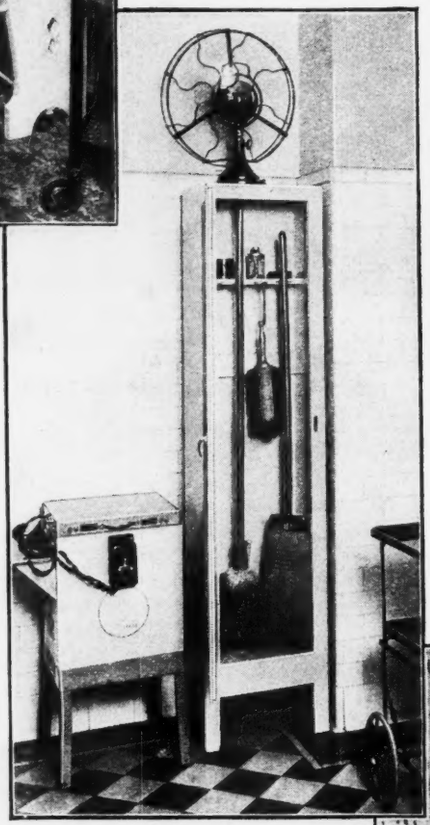
WHEN President and Mrs. Coolidge were "settling" in the White House at Washington a year ago, they paid a visit to the "Home, Sweet Home" model house, the modernized replica of the birthplace of the composer, John Howard Payne, erected for the observance of Better Homes Week in Washington. It was standing just back of the White House at that time. The Associated Press news dispatch, describing the visit, included the following paragraph:

"They spent about fifteen minutes going over the house and both asked many questions of attendants. The President was particularly interested in the lighting and ventilating features. Among other things he pointed out there was no provision for icing the kitchen refrigerator from the back porch." This defect was immediately remedied, I learned later.

Every kitchen should have ample artificial light above the range, the sink, the worktable, in the entry, at the head of the basement steps, and near the refrigerator. Where electricity is used, plenty of power convenience outlets must be included for the iron, percolator, toaster, washer, mangler or ironer, fan and other conveniences, at the points where these are to be used.

In all planning one of the main points to bear in mind is the use of stock

(*Continued on page 143*)



Corner space never need be wasted in your small kitchen. Built-in broom closets like this, and corner dish cabinets of similar size and shape, with shelves for dishes, utensils, and food supplies, are stock productions that can be set into new or old houses

With the passing of the pantry, this type of cabinet has come into its own. Its scientifically designed compartments, storage space and fittings greatly reduce wasted steps and efforts. Built-in and moveable designs of various sizes and costs are available

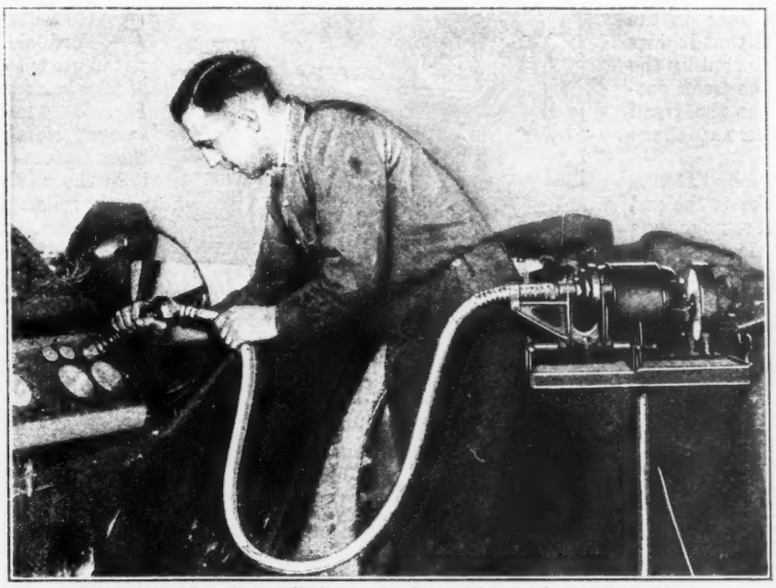
Keeping Your Car Free of Carbon

By E. B. Staples

MR. STAPLES, an expert automobile mechanic of Eureka Springs, Ark., is one of the regular readers of POPULAR SCIENCE MONTHLY. What he says here about carbon and its prevention is based on his years of practical experience as mechanic and driver.

OUTSIDE, possibly, of chronic tire trouble, carbon is the most distressing nuisance of motoring. No experience that I know of is more annoying than operating a car with carbonized cylinders. It is difficult to start it. The motor becomes overheated quickly. It misses. It pounds and clanks as though trying to shake itself apart on the slightest hills. It is sluggish and unresponsive on level roads. It consumes an enormous quantity of gasoline.

Driving such a car is a nerve-wracking and exasperating process. It is dangerous, too, for a car that will not accelerate immediately when the throttle is opened, is a poor vehicle to which to intrust your safety in an emergency.



Removing carbon from cylinders and valves with a newly invented electric brush of steel bristles, driven by a small motor through a flexible shaft

THERE are two things to do about carbon. One is to get rid of it if you have it; the other to take care that it doesn't come back. Neither of these is especially difficult.

Carbon deposits in the cylinders of a motor-car come from two sources—gasoline and lubricating oil. Both are chemical combinations of hydrogen and carbon; hence, carbon is an essential constituent of each and cannot be removed from them if they are to fulfill their purpose. The carbon that comes from gasoline has a dull, sooty appearance and is likely to be deposited in all parts of the combustion chamber. Oil carbon has a glassy sheen, and, except in extremely bad cases, is likely to be found only on the tops of the pistons.

The gasoline carbon deposits are due to incomplete combustion. If your carburetor adjustment is too rich, if you are constantly feeding to your motor more gasoline than is necessary, carbon will be formed. There is no escaping it any more than you can prevent a lamp from smoking when the wick is turned too high. In either case you are admitting too much fuel containing a great amount of carbon to be consumed in the available supply of air.

Your motor will become carbonized from lubricating oil for a similar reason. If you have loose pistons, or poorly fitting piston rings that permit the oil to seep through to above the pistons, part of this seepage will be consumed, and you'll notice a bluish smoke issuing from the exhaust. But at the same time the unconsumed carbon, released from the oil during the burning, will be deposited in the cylinders. Too much oil—using an oil that in body and quality is not suited to your engine, permitting the oil in your crankcase to become so thin that it will pass by even well-fitting rings and pistons—will cause carbon in the cylinders.

These, then, are the principle causes of carbon. What are you to do to get rid of it?

The simplest and one of the most effective ways is to scrape it out. If your car has a removable cylinder head, you can scrape the carbon from each cylinder with a putty knife or similar tool. If you cannot remove the cylinder head, you will have to supply yourself with the scraping tools made especially for the purpose of removing carbon. These are operated through the valve cap or spark-plug openings.

THREE such tools usually are necessary—one for the piston head, one for the cylinder head, and one for the various curved surfaces within the combustion chamber. Scrape with each tool until it no longer scratches, but slides easily over the surface. Then with a bellows blow the carbon dust out of the cylinder. This dust, carelessly left in the combustion chamber after scraping, will become red hot when you run your motor and will cause pre-ignition and carbon knocks just as if the cylinders had never been scraped.

A substitute for scraping, recently invented, is in the form of an electric brush with steel bristles, driven by a small motor.

THE best known way of removing carbon, however, is to burn it out with an oxygen torch, a method employed in service stations and garages. An oxygen decarbonizer is an expensive apparatus, however, and few persons except repair-shop mechanics have access to them.

Another way of removing carbon that, I am assured, is very successful, is the use of chemicals. Several preparations on the market, when poured or sprayed in the cylinders, are supposed to dissolve the carbon accumulations and to cause them to be discharged through the exhaust when the car is operated. Still another method of fighting carbon with chemicals is by mixing certain powders or liquids, which are sold commercially, with the gasoline. These chemical preparations are said both to remove carbon and to prevent its formation by chemical action in the natural process of consuming the gasoline. Among the newest of these preparations are boyce-ite and ethyl gas, both of which are said to have proved their efficacy in scientific test.

Now, assuming that your car is free of carbon, how are you to keep it so?

The first thing is to make certain that

(*Continued on page 156*)

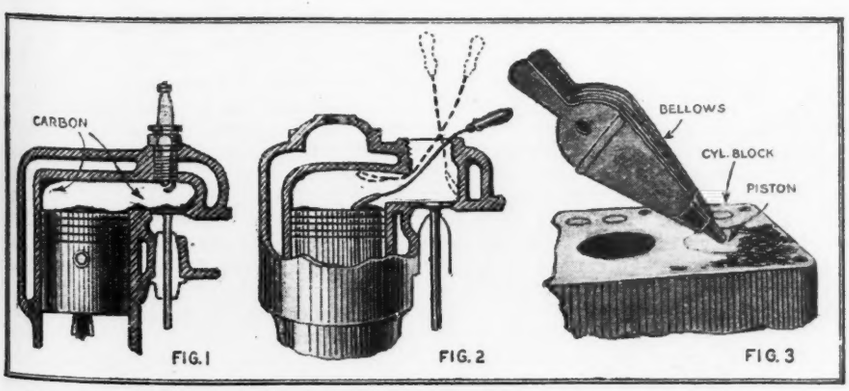


Figure 1 shows the points in the cylinder where deposits of carbon are most likely to collect. In Fig. 2 are shown the uses for three special types of scraper in scraping the piston head, the cylinder head, and the out-of-the-way cavities around and over the valves. After the scraping, the carbon should be blown out thoroughly with a hand bellows, as shown in Fig. 3

Ideas that Cut Garage Bills

How the Motorist Can Save Time and Money

WHY are wabbly wheels so prevalent? It is easy enough for one driving along the road to see the other fellow's wheels, but it happens very frequently that a man will drive for months before he realizes that his own are out of line. At times the wear on the tires is so slight and gradual that it does not show; but it may be detected by the sharp edges on one side of the tread pattern. Run the hands across the tread pattern from each side. If there are sharp edges, they will be felt.

In alining front wheels, the first step is to loosen the tie-rod bolt-yoke at the end of the steering reach rod and remove it as shown in Fig. 1. Since these yokes are clamped to the threaded portion of the reach rod, it will be necessary to loosen the clamp bolt and then turn the yoke on or off, depending on the amount and the way in which the wheels are misalined. In at least one case, right- and left-hand threads are used and the adjustment is made by loosening the yoke - clamp bolts at each end and then turning the reach rod. The center of the tire must measure from ¼ to ⅜ in. closer at the front than at the rear. Set the wheel on a jack and mark the center of the tire by holding a soft lead-pencil against the tire as it spins. Measure with a stick.

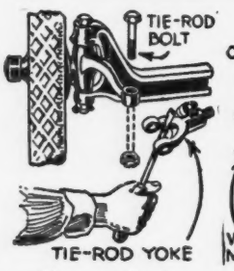


Fig. 1. Adjusting the tie-rod yoke

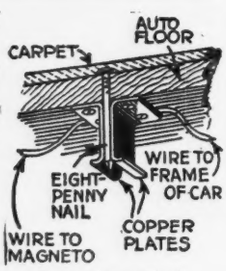


Fig. 2. Secret ignition lock for Fords

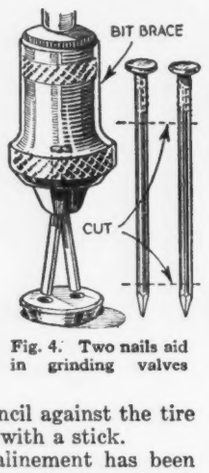


Fig. 4. Two nails aid in grinding valves

When the proper alinement has been secured, the tie-rod bolt is cleaned and replaced, the cotter key inserted and the clamp bolt locked tight. Regular inspection is essential for maintaining front wheels in proper alinement.

Fig. 3. Assembling the Ford universal

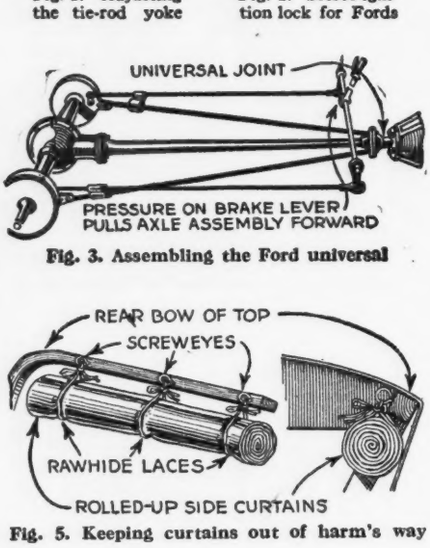


Fig. 5. Keeping curtains out of harm's way

ONE of the cheapest and most efficient means for locking a Ford car is shown in Fig. 2.

First, get two small strips of copper, bend these in the shape of a shallow U with an inch left flat at each end. Then punch holes in these flat ends and screw them on the under side of the floor boards. Be sure and leave only enough space between both strips so that a common eightpenny nail will touch them when inserted between.

One of these strips is connected with a wire to the magneto binding post and the other is grounded. When the nail is placed the current can flow through the circuit; but when the nail is removed, the electrical circuit is broken and it would take some time for a thief to find the trouble.

THE troubles incident to connecting the universal joint of a light popular type of car can be overcome to a large extent by the simple expedient of connecting the brake rods to the hand-brake lever, as shown in Fig. 3. Working on the region of forward and over the car most inthe universal, it is convenient to bring the axle forward when entering the squared end of the universal and holding the axle in position while inserting the connecting bolts. With the brake lever connected with the axle assembly, the worker, singlehanded, easily can pull the axle assembly forward and hold it in position.

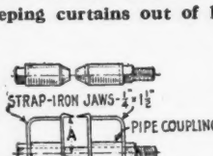


Fig. 7. A homemade spring-leaf spreader

In spite of its simplicity, this suggestion has not been widely practised, possibly because it is known only to a somewhat limited number of mechanics. The individual owner will find this method well worth adopting in the course of repairs that involve connecting the ever troublesome universal.

WHERE valve heads are provided with holes instead of a screwdriver slot, the method shown in Fig. 4 can be utilized while grinding them. Two nails are inserted in the chuck of a hand brace, the heads having been cut off previously. The nails then can be spread to provide any hole centers, while the chuck will hold them in position so that removal becomes quite simple.

A CONVENIENT method of carrying Ford side curtains when they are not in use is to hang them up in the corner at the back and close to the top, as in Fig. 5. Place three screweyes in the wooden cross piece and secure to each of these a piece of rawhide belt lace by tying it in the middle. The curtains are then neatly rolled up and tied as shown in the illustration. This keeps the curtains in much better condition, and they are always handy when wanted without disturbing the occupants of the rear seat.

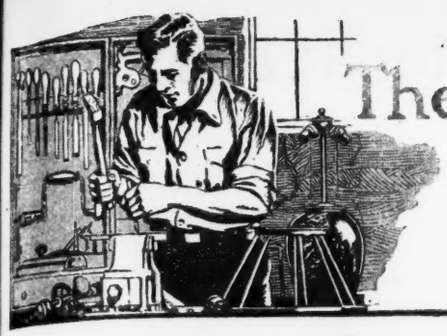
RAIN-WATER or distilled water should be used in the storage battery. For some autoists it is not always convenient to obtain distilled water. One way to collect rain-water is to place a large glass funnel in a milk bottle and set it out on the lawn (see Fig. 6). The water should not come in contact with any kind of metal and it is best to wait for a half hour or so after the rain starts to get the cleanest water free from dust in the atmosphere. The bottle, when full, must be kept sealed to prevent dust or dirt getting into the water.

Fig. 6. Gathering rain-water for the battery

FAILURE to lubricate properly the springs of an automobile causes the spring leaves to rust, or "freeze," together, which results in annoying squeaks and spring breakage.

The device shown in Fig. 7 will spread the leaves of the springs far enough apart to permit the insertion of lubricant. Each of the spreading jaws is made of strap iron bent as shown, with the ends ground down to a wedge shape. The blunt end is bent around so as to butt against the back of the wedge and act as a support. A clearance hole for a ¾-in. bolt is drilled through the jaws with a distance, *A*, sufficient to allow the spreader to reach over the maximum thickness of the spring to be lubricated. Pipe nipples placed as shown serve as braces to keep the sides from buckling when the nut is pulled up.

To use the spreader the wedge ends of the jaws are placed between the spring leaves on either side and the nut tightened with a wrench until the wedges pry the leaves apart. The best lubricant is a mixture of graphite and cylinder oil stirred into a thin paste and applied with the blade of a knife the full length of the spring leaves.



The Home Workshop

Arthur Wakeling, Editor

An Easily Built Radio Cabinet

Valuable Hints on Furniture-Making for Beginners

By Edward L. Munson

PERHAPS your inclinations are much the same as mine. I like to putter around my little cellar workshop. Doing the necessary house repairs, putting up shelves, easing cranky doors, making and repairing screens, fixing up toys and kites for the kiddies, and painting and varnishing—these are a real hobby with me. But they don't satisfy altogether my workshop ambitions. I've always wanted to make furniture or put up cabinetwork fit for the living-room.

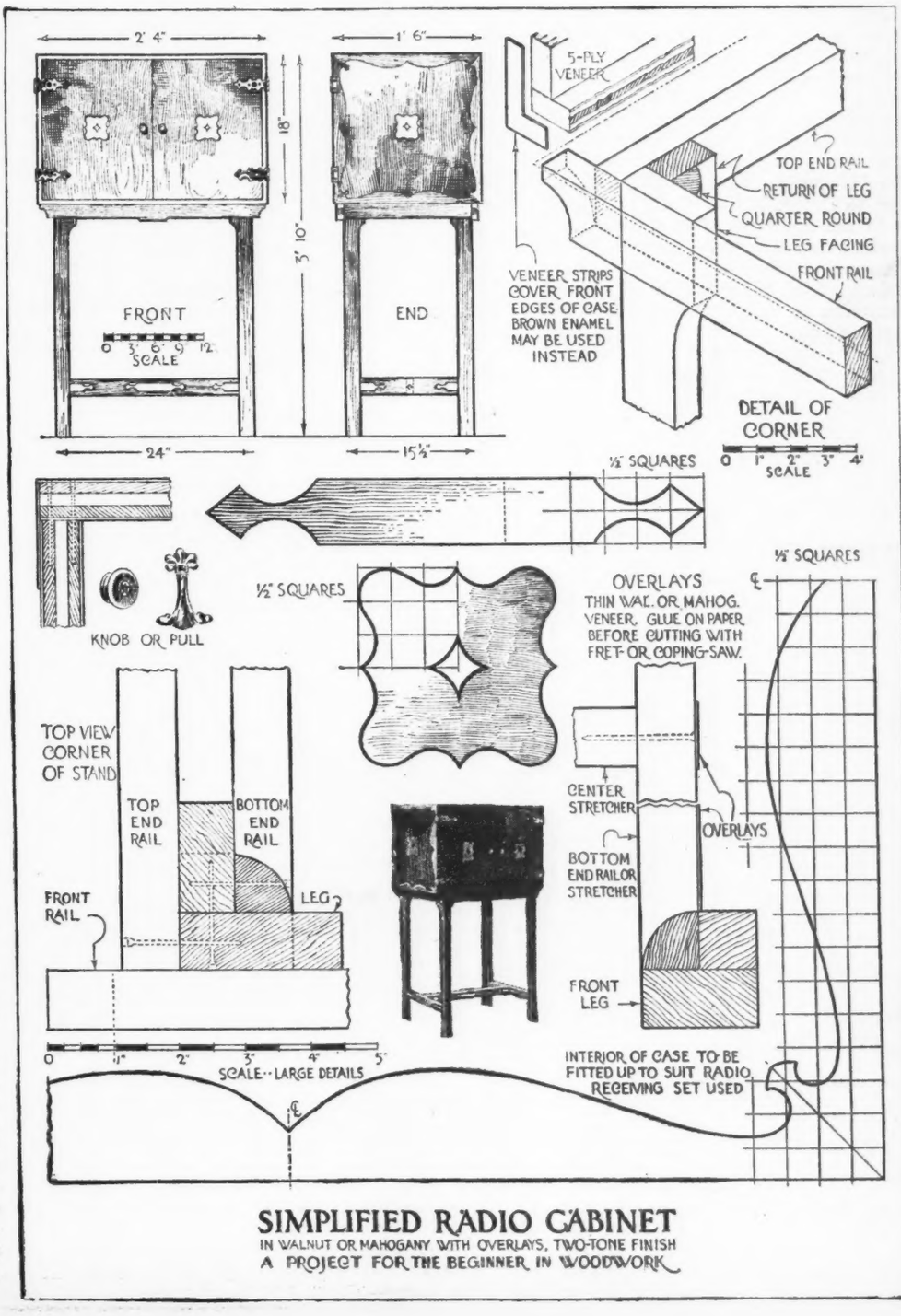
"That's where the real sport of making things comes in," I have said to myself many a time, when looking at furniture details in POPULAR SCIENCE MONTHLY. "It must be fine to carry through one of these pieces, one step after another, as time permits, with the certainty that the finished work will be worth while."

AND I have pictured myself saying casually to a visitor, "Oh, yes, I made that smoking-stand. It's walnut. Notice the choice figure of the wood in those door panels."

I have more than one friend who always has something like that to show and say, but they are all good workmen or have had the benefit of considerable manual-training instruction. That's where the difference comes in. I know next to nothing about cabinetwork. Whatever knowledge I have of woodworking tools comes from the trial-and-error sort of experience that so many amateur mechanics have; and, besides, I have only a small kit of tools—just the average outfit.

It so happens that the Home Workshop Editor of POPULAR SCIENCE MONTHLY commutes to New York from the same suburban town as I do, so I remarked to him several months ago on the predicament of workers like myself who would like to make worth-while furniture and yet haven't the time, tools, nor knowledge.

(*Continued on page 114*)



SIMPLIFIED RADIO CABINET

IN WALNUT OR MAHOGANY WITH OVERLAYS, TWO-TONE FINISH
A PROJECT FOR THE BEGINNER IN WOODWORK

How to Construct an Upholstered Footstool

By William T. Weld
Shopwork Instructor, Peoria, Ill.

IF YOU have been avoiding upholstery work because you do not know how to do it, you will find this article most helpful. It is the first of a series prepared especially for POPULAR SCIENCE MONTHLY by William T. Weld, an expert on this subject. Next month he will tell how to make flag or rush chair seats.

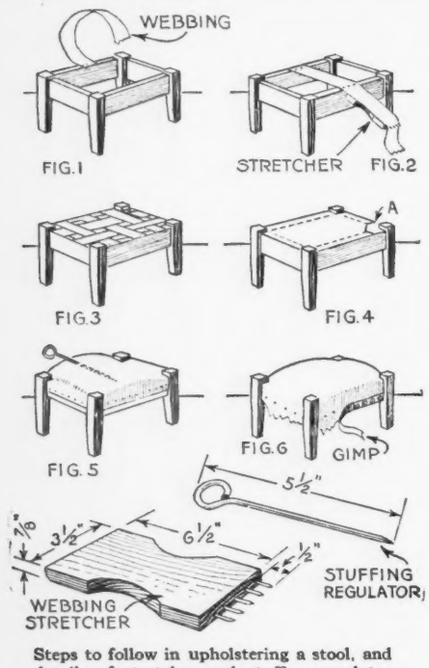
THE making of a stool similar to either of those illustrated is an enjoyable pastime, and the finished product will find a useful place in any home. Few tools are required and the cost of materials is reasonable.

The construction of each design is made clear in the working drawings below at the right. Design No. 1 requires a mortise and tenon joint in each corner. The section *AA* shows that the tenons must be mitered or cut at angles of 45 degrees and that a space is left between the tenons where they meet in the mortise.

If the first design is chosen, the rails may be made of any soft wood, as they will be entirely covered when finished. The soft wood is much easier to tack into. The legs should be made of some wood that will take a pleasing finish. Oak or black walnut are very good, but if you cannot obtain these, a piece of yellow pine 2 by 4 by 18 in., ripped down the center, and cut in two crossways, will provide four good legs. These should be well sanded and an oil stain used.

Should you decide to make a stool similar to Design No. 2, it will be necessary to use the same kind of wood for the rails as for the legs. Figure 9 shows the reason for this.

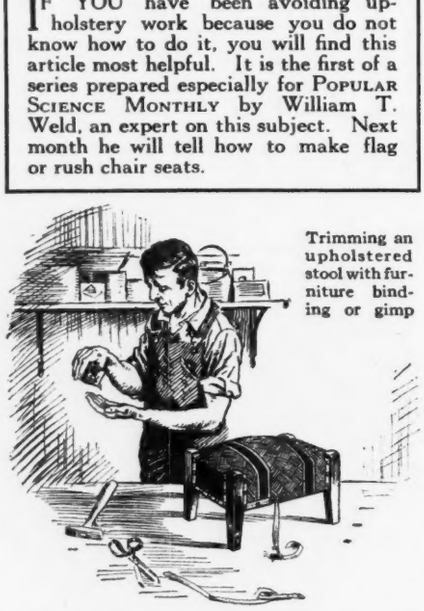
A doweled joint is shown in the corner construction for this stool, but a mortise and tenon could be used if you prefer. In laying out a doweled joint, always work to center lines and use a very sharp, hard pencil or a knife for marking. You will find it of great aid in securing accuracy in such a layout to place a leg and rail in their relative positions in the vise



Steps to follow in upholstering a stool, and details of stretcher and stuffing regulator

or a clamp and mark for all four openings before taking them apart.

The curve for the rail should be drawn on heavy paper and transferred to the wood after it has been cut out from the paper. A coping- or scroll-saw should be used to make the cut, taking care to hold the saw-blade square with or at



Trimming an upholstered stool with furniture binding or gimp

right angles to the surface of the rail.

The upholstering of both stools is the same with the exception of the final covering and the binding. In the case of Design No. 1, the gimp or binding used as a finish continues around the inside of the legs (Fig. 7). In No. 2 no gimp is used. The final covering is carefully fitted around the legs, drawn down to a straight line on the rails, and tacked as in Fig. 9.

After the frame has been built, it should be thoroughly sanded, given a coat of stain and two coats of good varnish, and allowed to dry in a dust-free room. You are then ready to begin the upholstering.

There are several kinds of webbing on the market; but for our purpose the 3½-in.-wide, close weave should be chosen. About 2 yds. will be required. The inner edges of the rails should be filed or sanded a trifle before the webbing is tacked, as this will prevent its wearing through in use.

Figure 1 shows how to begin. Let the webbing project about ¼ in. toward the inside and drive in three 10-oz. tacks, keeping the outer ones about 3/16 in. from the edges of the webbing; then fold over as shown and drive in three more tacks at places that will just miss the lower ones. This same method is used in all cases.

THE webbing is stretched as shown in Fig. 2. The end then is cut off about 1 in. beyond the rails, folded back over the first tacks, and tacked again.

The weaving is shown in Fig. 3.

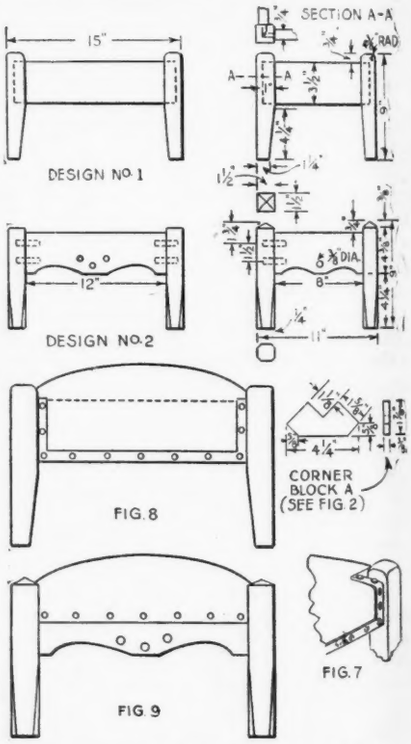
The stretcher may be made of any scrap wood of the size shown. This stretcher also serves as an effective clamp in holding the rails to the legs while the glue in the joints is drying.

Next, you should cover the webbing with burlap. Cut a piece larger than the stool frame—about 1¼ in. should project beyond the edges of all four rails. Tack this in place with a few 4-oz. tacks. Cut out a square piece at each corner and fit the burlap around the legs.

Take some of the material you are to use for stuffing and make several rolls of it. These should be rolled quite tightly and when finished would be of a diameter slightly larger than a pencil. Lay these rolls along the edges of the rails and turn the projecting edges of the burlap back over them (Fig. 4). Push the roll out to the edge of the rail and holding it in place under the burlap, drive in tacks all along the edge. Take care not to let this rolled edge project beyond the face of the rails, as this will spoil the appearance of the covering when it is put on. This edging will protect the final covering from wearing through.

Corner blocks made as indicated and having their outer edges rounded a little next are nailed in place in the corners with a few small nails. (*A*, Fig. 4.) These blocks should fit snugly against the two inner faces of the legs. They form a place into which tacks may be driven when making the turn around the legs.

Any stuffing such as moss, tow, curled hair, or excelsior may be used. Tow is inexpensive and makes a good job. Make a pile of it about twice as high as you want the final shape to be. One pound usually is enough. Spread it out evenly over the burlap, being careful to remove any hard sticks or lumps that it may



Working details of two types of stools, and methods of applying the top coverings

contain. Only a small amount should be put on the corner blocks.

Next, cover the stuffing with muslin, beginning on one side rail by turning the muslin under about an inch so as to tack through two thicknesses of material

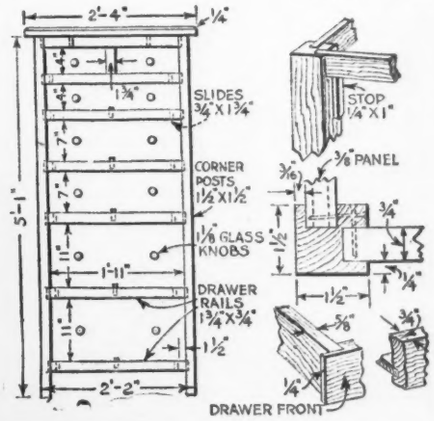
(*Continued on page 127*)

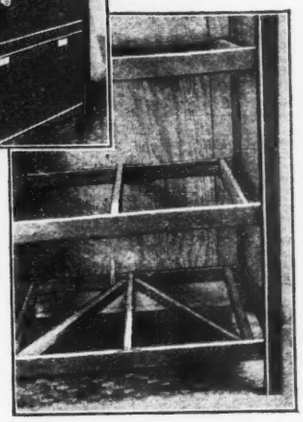
A Roomy Filing Cabinet for Your Papers

By Edwin M. Love

THE filing cabinet illustrated was built to fill the need that sooner or later every man feels—the necessity of having plenty of room to keep his papers in an orderly manner. The material cost $10, so that, in comparison with the cost of a commercial cabinet, the builder was well paid for the time expended in constructing the piece.

Simplicity and low cost are features of this cabinet





The completed cabinet and the lower part of the framework are illustrated at the left. Above is a dimensioned front view and details of the corner and drawer construction

The novel joining of rails and posts commends itself for simplicity and strength. The four corner posts are of stock fir, 2 in. by 2 in., surfaced four sides; but the actual dimensions are 1½ by 1½ in. Cut these 4 ft. 9 in. in length, and select the two best adjacent sides of each, marking them for face sides.

Lay off the two front posts according to dimensions given in the elevation, and cut mortises ⅝ in. deep by ¾ in. wide to receive the ends of the rails. Be careful to make the two in pairs, keeping the mortises back ¼ in. from the front faces.

Next, cut similar mortises in the posts for the top and bottom side rails, keeping them 3/16 in. back from the outside faces. Plow ⅜-in. grooves ⅜ in. from the side faces, making them ½ in. deep, and running them from the top to the bottom rail mortises. The rails are ¾ by 1¾ in. net by 18 in., plowed in the center of one edge to a depth of ½ in.

Two pieces of 3-ply fir panel veneer ⅜ in. thick are cut to a width of 18 in. and a length of 4 ft. 5¾ in., keeping them square and straight. Assemble a front post with the two rails, a piece of panel veneer, and rear post. Glue the ends of the rails and clamp the posts firmly over the edges of the veneer, afterward nailing through the groove from the inside surfaces of the posts. The resulting panels are neat and substantial.

Rabbet the inside back edges of the back posts ½ in. deep and ⅜ in. wide, to receive a back panel of veneer 2 ft. wide and 4 ft. 5¾ in. long.

The seven front rails are cut 2 ft. ¼ in. long. Six are dadoed ¼ in. deep 2 in. from the ends, to receive the drawer slides shown in the sectional photograph. One is left plain.

In assembling the side panels with the rails and the rear panel, glue all the rail joints and draw them closely together with clamps, nailing through from the inside. Cut the back rails between the rear posts opposite the front rails and nail in slides as shown, keeping the upper edges flush with those of the rails. Put in the center guide slides, keeping the upper edges ¼ in. above the rails. Brace the bottom as indicated.

The center muntin between the two small drawers is of the same material as the rails, and is toe-nailed to the top and second rails.

Build the drawers in the usual way by rabbeting the sides into the ends of the fronts. Use ⅜ in. by 6 in. tongue-and-groove pine drawer bottoms in grooves made ¼ in. from the bottom edges of the sides. Nail guide strips on the bottoms.

Enough clearance must be kept on the sides to allow of stops ¼ in. thick being nailed to the front posts on each end of the drawer openings. The drawers, which close flush with the rails, may be divided by partitions to meet the individual needs of the builder. The glass drawer pulls are not put on until after the finishing is done. The cabinet may be stained, shellacked, and either varnished or waxed, or it may be painted, as preferred.

Cabinet Type Bench Made Cheaply from Old Washstand

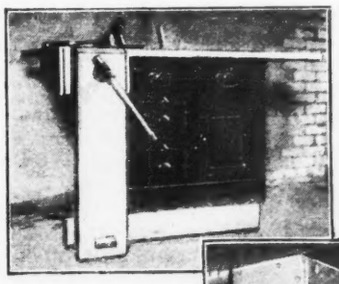
By Austin G. Tribute

A BENCH is the first requisite in starting a home workshop, and it is reasonable to suppose that the owner wants to be as proud of it as of his tools. True, he might improvise one from a few planks, but the result would be neither pleasing nor altogether satisfactory. On the other hand, to build a pretentious bench requires another one for working up the stock lumber. There is, however, a way to build a compartment bench very quickly and at little expense.

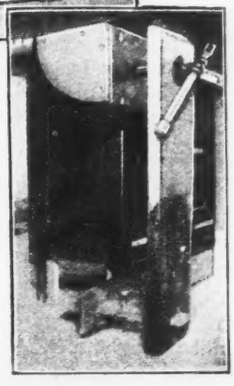
You will need a discarded washstand. If there is none in attic or cellar, visit a secondhand dealer, from whom you probably can buy one for about $1.50. Small defects do not matter, for they are easily remedied.

First remove the drawers and towel-rack. The back boards, which usually are nailed on, should be knocked off carefully with a hammer. The screws retaining the top then are accessible for removal.

A new top of birch or maple will replace the old one. If the washstand is about 30 by 17 in., as mine was, it will carry a bench top 4½ ft. long, 22 in. wide, and 1½ in. thick. The use of dowels will be necessary, as two pieces of plank will be required to get the width. Glue doweled joint, and, when dry, smooth off any inequalities.



The front view of bench (left) and the vise end (below)



Attach the new top with substantial screws to the frame of the washstand through the holes already there. Make slots in the back edge to hold try-square, gage, and one or two chisels.

The next step is to estimate the height at which you can work best (have the top high enough) and add hardwood legs 3 in. wide and 1½ in. thick. Screw them to the inside bottom corners. Then replace the back boards and drawers and renew broken knobs and hand-pulls.

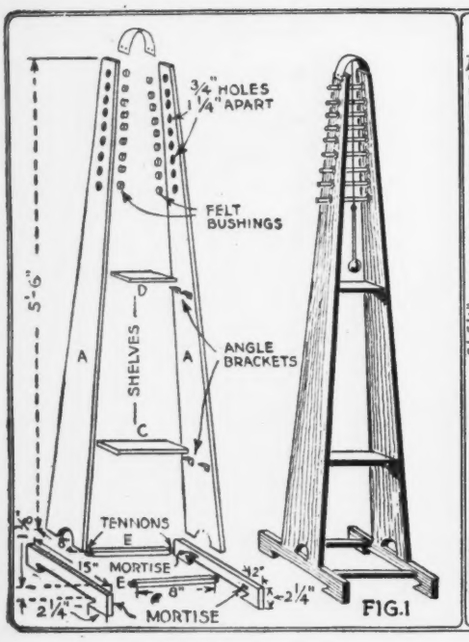
If the bench is not firm enough for work that requires heavy planing, it can be braced with diagonal strips across the back or otherwise reinforced where necessary.

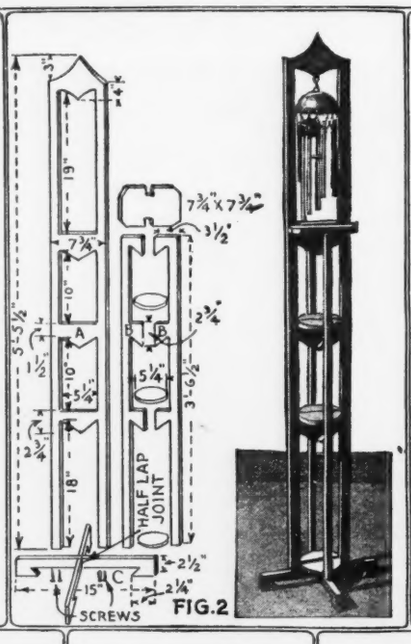
As for a vise, the kind will depend on the sort of work that interests you most. By way of suggestion, the old-fashioned screw vise is cheap and rugged. The screw and wooden handle cost a little over a dollar. The two jaws generally are made of 2-in. oak, although birch was used in the one illustrated. The outer jaw reaches downward almost to the floor, while the other may be short, secured to the bench top with bolts and supported by an end piece.

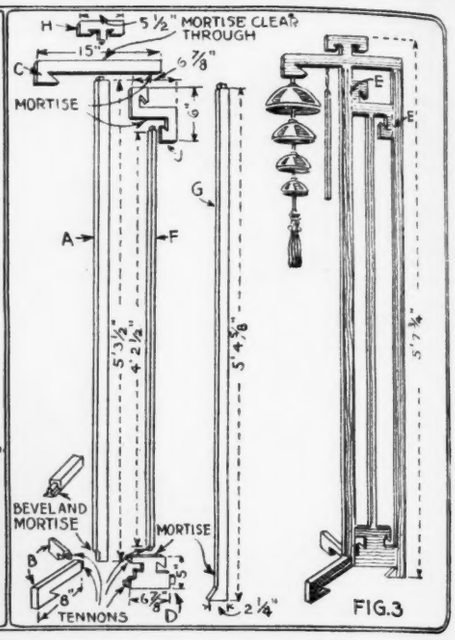
In order to hold the outer jaw parallel to the inner, the device shown is used. A

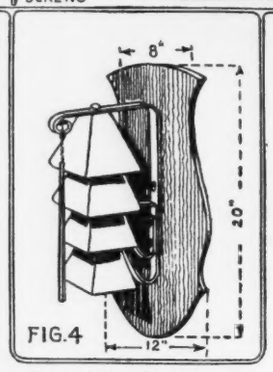
(*Continued on page 122*)

Craftwork Holders for Gongs and Chimes









Four styles of simple supports to hold ornamental dinner gongs or chimes

By J. T. Garver

OF CHARACTERISTIC sturdiness and originality, the Dutch craftwork dinner-gong mountings illustrated are interesting and unusual pieces for construction in your home workshop.

Oak preferably should be used in building them, but soft woods, such as pine, poplar, cypress, and chestnut of selected grain, will answer the purpose well. The stock should be planed and sanded well. A clear, sound board ¾ by 12 in. and 14 ft. long will allow for some waste in the construction of any of these pieces.

The gong shown in Fig. 1 is made by mounting a series of brass tubes of different lengths and tones with felt bushings through corresponding holes in the two uprights, *A*. Ordinary tube-phones are adapted to this purpose, and a tune may be played upon them.

The uprights *A* are each 5 ft. 6 in. long, tapering from 8 in. at the bottom to 4 in. at the top. The base pieces, 2¼ by 15 in., are beveled back on the under edges 2¼ in. from each end, making them 1⅛ in. wide inside. They also are mortised 2 in. from the ends, but not clear through, to take the corresponding tenons cut in the cross rungs, *E*, which are ¾ in. square and 8 in. long, not including the tenons.

THE base pieces and the cross rungs are glued and pinned together and fastened to the uprights with glue and long screws from the bottom.

Shelf *C*, 5 in. square, and shelf *D*, 4 in. square, are beveled to suit the slant of the uprights and are fastened to them with 8 angle brackets and screws at distances of 2 ft. and 3 ft. 4 in. respectively from the bottom.

The ornamental spanner at the top, from which the hammer is suspended with a chain or cord, is of brass or copper and is fastened with 4 round-headed ½-in. screws.

The holes for the brass tubes should now be bored. Carefully mark on each side, beginning 1¼ in. from the top, and bore ¾-in. holes straight through and across the uprights. Make the holes 1¼ in. apart. Chamfer off all edges and, after the stain and finish have been applied, insert the bushings and tubes and hang the hammer.

The upright, *A*, of the gong holder in Fig. 2 is sawed from wood 7¾ in. by 5 ft. 5½ in. The pieces *B*, each of which is 3½ in. wide at the three widest points and 3 ft. 6½ in. long, are fastened with screws and glue to *A*. The upper shelf, 7¾ in. square, is notched 1⅛ in. on two sides to make a flush fit with the outside of *A*. The three lower shelves may be either round or octagonal. They are 5¼ in. in diameter. These shelves are pushed into their places and need no further fastening.

The base, *C*, is made by halving at the center 2 pieces similar to those used for the base of the stand in Fig. 1, and is fastened to the uprights with glue and long screws. The gong is suspended with an ornamental screweye and chain.

Figure 3 is an assembly of 9 pieces of the dimensions and shapes indicated. The mortise and tenon joints are well glued and those at *E* are pinned as well as glued.

The upright *A* is 1⅛ in. wide and 5 ft. 3½ in. long, beveled and mortised 1⅛ in. at the bottom to fit tenons in the base pieces *B*, which are 2¼ and 1⅛ in. wide at the wide and narrow portions, and 8 in. long. Piece *A* also is tenoned at the top to fit a mortise in *C*.

The ornamental bottom block, *D*, is 5 by 6⅞ in.; the upper block *J* is cut from a piece 6 by 6⅞ in. These parts are mortised for the upright, *F*, which is ¾ in. square and 5 ft. 4⅝ in. long, not including the ¾-in. tenons at each end.

The upright, *G*, is 1⅛ in. wide, except at the bottom, where it is 2¼ in., and 5 ft. 4⅝ in. long. Allowance should be made for the ¾-in. tenon at the top. The cross bar, *C*, is mortised for *A* and *G*, the mortise for *A* extending clear through so that the ornamental top *H* can be tenoned into the same hole. The top *H* is 2¼ by 5½ in. over all.

In Fig. 4 is a small mounting for either tubes or bells. The over-all length of the board is 20 in. and the width runs from 8 to 12 in.

Making a perfect glue joint is not the difficult task many amateur woodworkers imagine. It depends upon the fit of the parts to be joined and, of course, the grade of glue used, which should be the very best.

DRIVE the parts together before applying any glue, to assure yourself that you have a real joint. Do a little squinting and, if necessary, try the parts together a number of times until they shoulder up. Small brads are then driven in the glued joint and if conspicuous should be countersunk and puttied.

All edges should be chamfered off before finishing the work. A brown Flemish wood dye is recommended, after which a light filler and a flat coat varnish, or wax, well rubbed, will bring out the fine grain of the wood and enhance the beauty of the lines.

The gongs or tubes may be obtained at or through any city supply house.

The charm and beauty of these pieces will be appreciated by the builder who conscientiously applies his best efforts and ability, thereby molding into his finished work a lasting usefulness and an individuality all his own.

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Machining Troubles and Their Remedy

By Albert A. Dowd
Consulting Engineer

THE foreman gave me 24 bronze bushings (*A*, Fig. 1) and told me to bore, face, and turn them to the sizes shown at *B*. The cored hole at *C* was small, rather rough, and full of sand, as I soon found out when I put a tool into it.

I held the work in chuck jaws on an engine lathe and first tried boring out the hole with a tool like that shown at *D*. This entered easily and passed partway through until it reached a point about at *E*, where the edge broke down so that I had to take it out and regrind it. After regrinding, it stood up long enough to finish the hole, but it needed grinding again after it had passed through all the way.

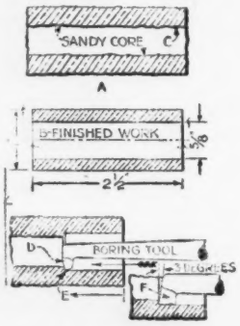

Fig. 1. Solving a boring problem by grinding the tool correctly

I saw that this method would not answer, so I took another piece and after placing it in the chuck, I put a 9/16-in. drill in the tailstock and fed it through the work. The hole produced was very bad and the cutting lips of the drill were worn considerably from contact with the scale. Finally, I obtained another boring tool, took it over to a wheel and ground it differently, as shown at *F*. After cutting and trying several times for diameter, I set it to bore the hole about 1/64 in. under size. This tool went right through the work, cutting freely, and the hole appeared to be very good. I followed it up with a reamer, which brought the hole to the proper size.

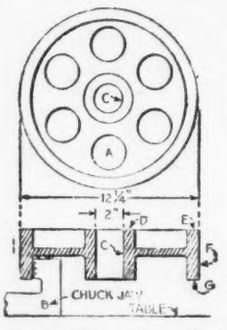

Fig. 2. This work required boring, as shown in the diagram at left, below

The boring tool required grinding only once for all the 24 pieces. The other operations on the work are immaterial as they consisted only of turning and facing on a mandrel. Although the bronze was hard and full of sand, the tool did not "crawl" up on the scale, because the shape of the point kept it in position so that the keen cutting edge was not subjected to wear. Since this experience, I frequently have ground boring tools in the same way with very satisfactory results when using them in cored holes.

Long cored holes often are troublesome in production work, because the sand in the core acts as an abrasive on the tool and soon ruins the cutting edge. If we attempt to drill a hole of this kind with a core drill, the tool has a tendency to follow the irregularity of the hole, and if this runs out of true slightly (as is often the case), the resulting hole will run out also. Hence, if it is afterward reamed, the hole usually will be slightly eccentric to the center of rotation of the work, though it may be correct as to size.

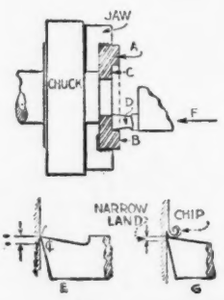

Fig. 4. How chatter may be prevented by shaping tools properly

I remember there was in the shop not long ago a bright young fellow, who was an exceptionally rapid operator on a vertical boring mill. This man had 50 castings to machine, as shown at *A* in Fig. 2, and he was holding them by the inside of the rim in chuck jaws, as at *B*, so that he could bore, ream, turn, and face the surfaces *C*, *D*, *E*, *F*, and *G* in one setting.

The cored hole *C* ran out of truth more or less with the outside portion *F* and the

(*Continued on page 96*)

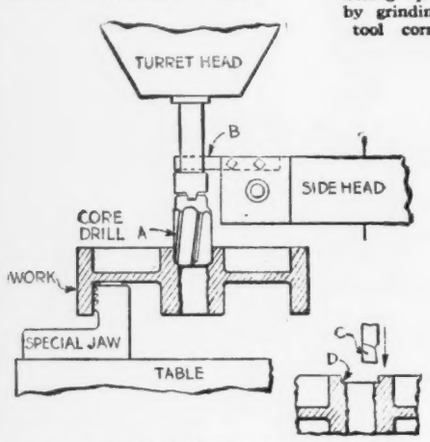

Fig. 3. Method of using a core drill that gave incorrect results, and the remedy

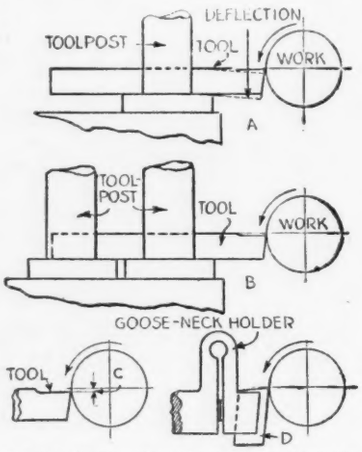

Fig. 5. Diagram that illustrates how chatter is caused and may be prevented in turning

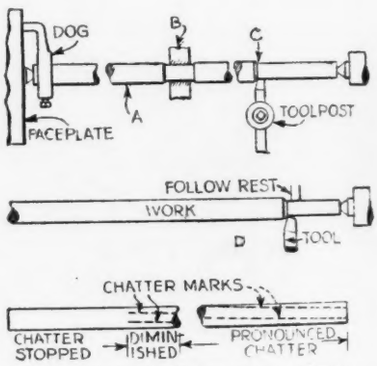

Fig. 6. Diagram illustrating peculiar chatter caused in long shaft as the result of torsion

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Unless you take real pleasure in your work, you never will know what real pleasure is.

A simple rule for getting the right cutting speed and feed for any tool is to give the tool all it will stand without burning.

Always lift a file on the return stroke; dragging it dulls the teeth and scratches the work.

Get the tool under the scale when planing or turning cast iron.

Hunting all over the shop for tools is waste of energy; keep them together.

The Burglar was fussy, too

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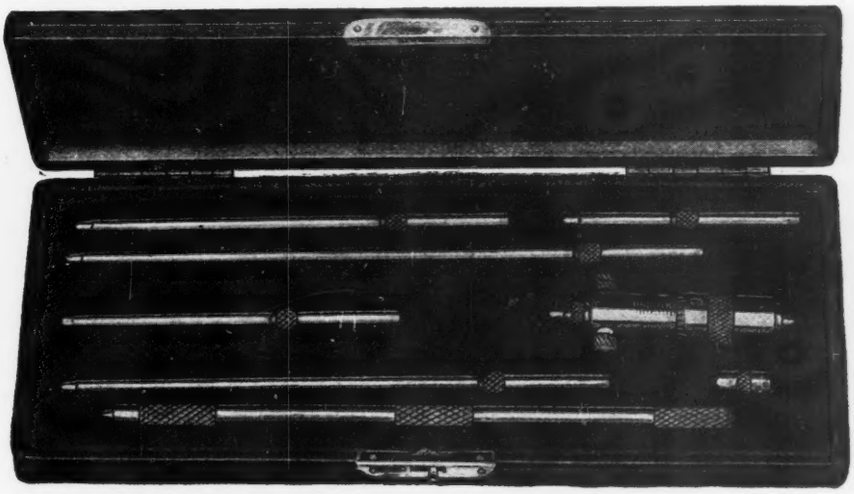
"I'll say he did. He was supposed to go out on a job today and took his tools home to get an early start. Somebody busted into his place, found the kit bag and picked out all the Starretts. Bill's madder'n a wet hen, but he says you gotta hand it to the burglar, he certainly knows tools."



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How to Solve Milling Problems with a Universal Dividing Head

By H. L. Wheeler
Machine-Shop Foreman

IN ALL toolroom work the universal milling machine is almost indispensable. Plain milling work is familiar to most mechanics, but to the novice in the toolmaker's art the use of the dividing head presents many difficulties. As a large portion of tool work is accomplished with the aid of the dividing head, it is necessary for the toolmaker to understand thoroughly the use of this attachment.

The first and most important step in this direction is to study the construction of the head and become familiar with the parts and their function.

A dividing head is a milling machine attachment used for indexing or dividing a piece of work into any number of divisions. Work of this character comes under two divisions, plain and differential; and these are sometimes subdivided into simple and compound indexing. Both classes frequently involve trigonometrical calculations, especially in laying out and boring holes in drill jigs when the locations of these holes are designated in degrees with relation to other working points of the jig.

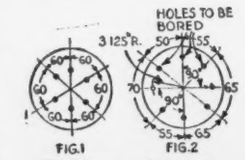
There are many designs of dividing heads in use. These differ only in the arrangement of parts; the general principle is practically the same for all. They are made with a 40-to-1 reduction — a single-threaded worm engaging a 40-toothed worm wheel mounted in a suitable housing — and by means of index plates having numbered circles accurately drilled, it is possible to obtain any fraction of a revolution of the main spindle.

As the worm wheel has 40 teeth, it will be apparent that 40 turns of the crank will produce one complete revolution of the spindle. All modern dividing heads are designed on this principle. Every index head is provided with one or more index plates, and special plates can be made for unusual purposes. In addition, it usually has a quick indexing plate attached to the spindle for obtaining all common multiples of 24.

Most index plates are drilled with a series of holes on 6 circles of varying diameter, each circle having a different number of holes and known in shop parlance as the "index circle." Some makers, however, provide a greater number of circles on one plate, so that fewer plates are required for a given number of circles.

Mounted on the same shaft with the plate is a pair of sector arms that serve as a guide in counting the holes and reduce the chance of error in counting.

To explain the operation of the dividing head, let us suppose we are to cut a gear having 72 teeth—plain indexing. The work is mounted on an arbor between centers as shown in Fig. 3. The cutter is centered with the work and set for the proper depth of cut. The driving dog on the arbor must be wedged securely in the slot with setscrews so that there will be no backlash when the work rotates; this is important in all indexing work.



Divisions easily made with dividing head

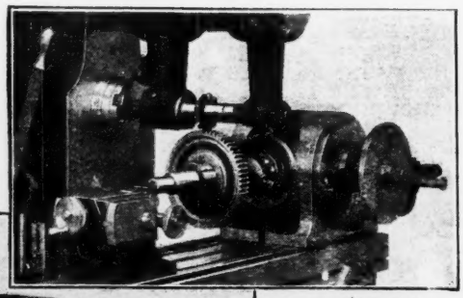


Fig. 3. Plain indexing on gear work

Photos courtesy Cincinnati Milling Machine Co.

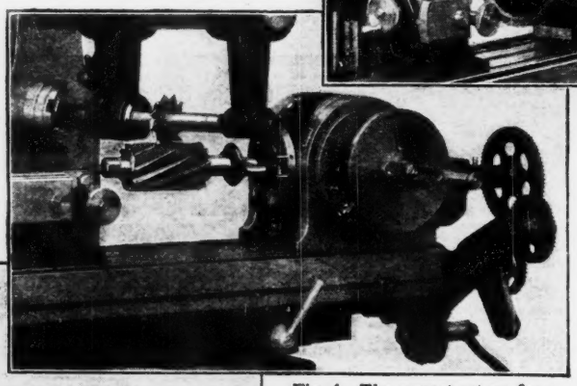


Fig. 4. The correct set-up for a typical job of spiral milling

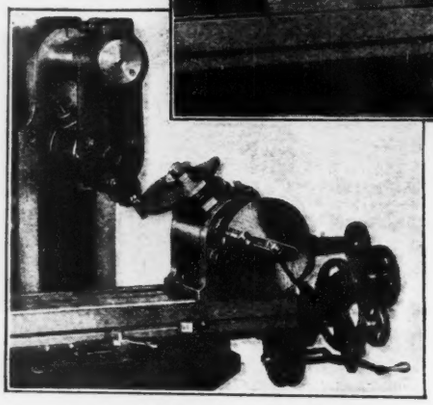


Fig. 5. Milling a cam of uniform rise with the aid of a dividing head

The index pin then is set for the correct circle, which is obtained from tables provided with the machine. If the correct circle is not found on the plate that is already attached, it will be necessary to change it for a plate having the correct circle.

Before starting to cut, make sure that everything is properly set and tight. To set the cutter for the depth, start the machine and bring the cutter in contact with the work so that it just touches. Now set the vertical feed dial to zero, raise the table the required amount, and we are ready for the first cut.

After the first tooth has been cut, the stop pin is withdrawn and the crank rotated the required number of turns to bring the stop pin to a new position. This operation is repeated until all of the teeth have been cut.

It sometimes happens that the index tables have been lost or destroyed, making it necessary to calculate the required number of turns. In any case a knowledge of how to do this will give a better understanding of the work in hand.

Take the gear we have been discussing as an example. To find the correct index circle without a reference table, proceed as follows: Divide the number of turns required for one revolution of the spindle by the number of divisions to be made on the work. This will indicate the number of turns and fractions of a turn on the crank required for one division. To illustrate: We have 40/72 = 5/9. Now we must select the index circle most convenient for this fraction. The rule is to select a circle having a number of which the denominator of the fraction is a common multiple. Looking over the plates available we find 18, 27, 36, any of which will do.

Taking the 18-hole circle, multiply 18 by 5/9 to obtain the number of holes the crank must be moved; then 10 holes on the 18 circle will index the gear 1/72 of the circumference of the circle or one tooth.

In selecting the circle always take the lowest number when more than one circle is available, as this requires the smallest number of holes to move the crank. Set the sector arms to count 10 holes on the 18 circle and proceed with the work.

Regular gear-cutting machines are built on the principle of the dividing head, except that the worm wheel has a greater number of teeth and the indexing is automatic instead of hand operated.

A CIRCLE can be divided easily into degrees or fractions of degrees. Figures 1 and 2 are typical examples. The layout in Fig. 1 may be expressed as 6 equal divisions that are equal to 60 degrees each (360 degrees divided by 60). In this case we would follow the same procedure as for the gear problem.

Figure 2 is somewhat more complicated. In the first division we wish to move the spindle through an arc of 55 degrees. One complete turn of the crank is equal to 1/40 of 360 or 9; then, dividing 55 by 9, we have 6 1/9 turns to make, or 6 turns and 2 holes on the 18 circle. To move for the next 65, we calculate 65/9 = 7 2/9, or 7 turns and 4 holes on the 18 circle. The same method is followed throughout.

Spiral milling is a combination of movements in the head and the feed screw of the table. Figure 4 shows a typical job of spiral milling and the correct set-up.

(*Continued on page 104*)

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AUTOMOBILE TOPS AND SEATS	S-W Auto Top and S-W Auto Seat Dressing			
BRICK	SWP House Paint S-W Concrete Wall Finish			Old Dutch Enamel
CEILINGS, Interior	Flat-Tone	Scar-Not Varnish	S-W Handcraft Stain Floorlac	Enameloid
Exterior	SWP House Paint	Rexpar Varnish	S-W Oil Stain	Old Dutch Enamel
CONCRETE	S-W Concrete Wall Finish			
DOORS, Interior	SWP House Paint	Scar-Not Varnish Velvet Finish No. 1044	Floorlac S-W Handcraft Stain	Enameloid
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FURNITURE, Indoor	Enameloid	Scar-Not Varnish	Floorlac	Old Dutch Enamel Enameloid
Porch	Enameloid	Rexpar Varnish	S-W Oil Stain	
HOUSE OR GARAGE Exterior	SWP House Paint	Rexpar Varnish	S-W Preservative Shingle Stain	Old Dutch Enamel
LINOLEUM	S-W Inside Floor Paint	Mar-Not Varnish		S-W Inside Floor Paint
RADIATORS	Flat-Tone S-W Aluminum or Gold Paint			Enameloid
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SCREENS	S-W Screen Enamel			S-W Screen Enamel
TOYS	S-W Family Paint	Rexpar Varnish	Floorlac	Enameloid
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WICKER	Enameloid	Rexpar Varnish	Floorlac	Old Dutch Enamel
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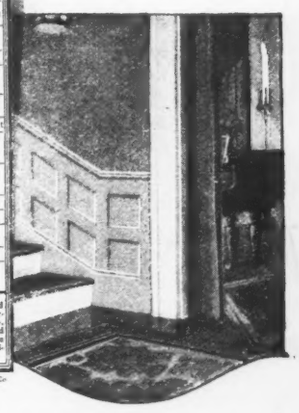

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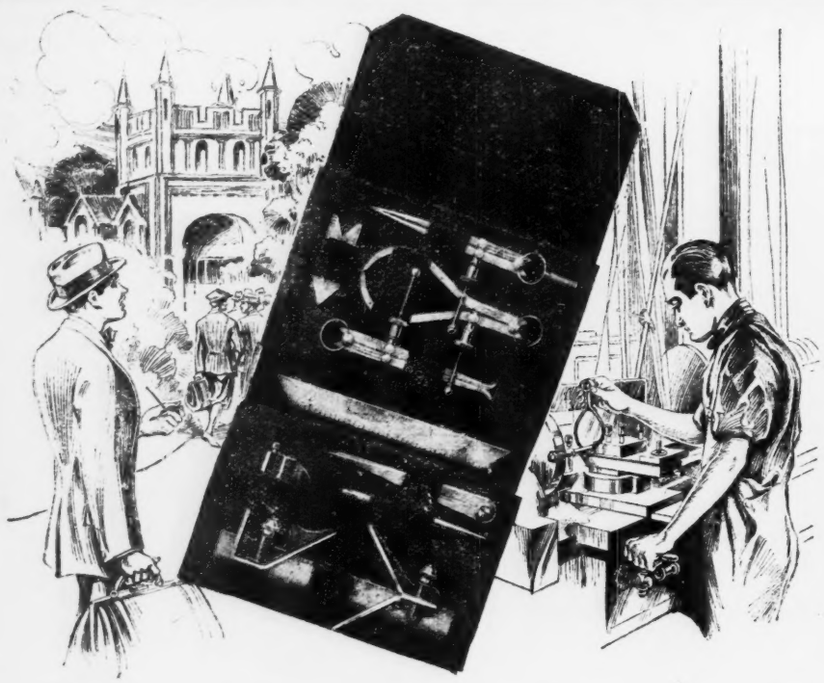

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If you want a handy pocket reference book write today for a Brown a Sharpe Small Tool Catalog No. 29.

The rectangular shape of the frame is a "Rex" advantage. Decimal equivalents of parts of an inch are stamped on the thimble.

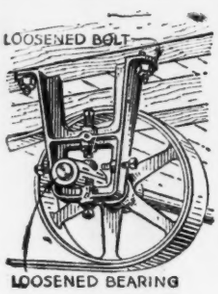
Brown & Sharpe Mfg. Co.
Providence, R. I., U.S.A.

"Standard of the Mechanical World"

How to Avoid Forcing New Belts over Their Pulleys

MILLWRIGHTS agree that it is bad practice to force one of the edges of a large belt to catch on a pulley and then run on the belt either by hand or by power. This is apt to cause the belt to stretch more on one side than on the other and injure it permanently.

Where conditions allow it, a good kink for putting large belts on the pulleys is to loosen the adjusting screws on the hangers, as shown. This allows the shaft to move over, temporarily shortening the distance between the shaft centers. Sometimes the shaft may be moved inward 2 in. or more, thus making it possible to put the belt on easily. Shortening the center distance 2 in. is equivalent to adding 4 in. to the belt's length. To assist further, one of the hanger bolts may be loosened to allow the hanger to swing inward. Where patented overhead beams are employed, it is sometimes possible to slide the entire hanger forward without touching the adjusting screws.



Belt is slipped over loosened pulley

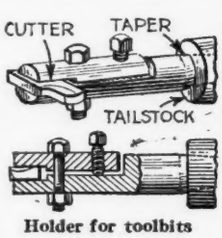
After the belt is on the pulleys, bring the hanger back to its normal position. This is a simple thing to do by turning the nuts where the first and second methods mentioned above are employed. The original position of the hanger should always be marked before moving, to avoid tedious realining. Turn the bearing and adjusting screws back to their original positions. These positions are easily found because the screw on the opposite side and the top screw need not be moved at all.

To be sure, this method is not always practical where there are belts running in both directions, as on a common line shaft, but where it can be employed, it is well worth while.—W. F. SCHAPHORST, Newark, N. J.

Simplified Lathe Tool Chucks

CHUCKS for holding a variety of lathe tools can be made quickly and easily along the lines shown in the accompanying illustration.

A short length of cold rolled steel is cut lengthwise with a saw to form the clamp jaw. The two parts then are connected quite loosely with a bolt. A setscrew at the rear of the movable jaw provides pressure for holding any form of small cutting tool.

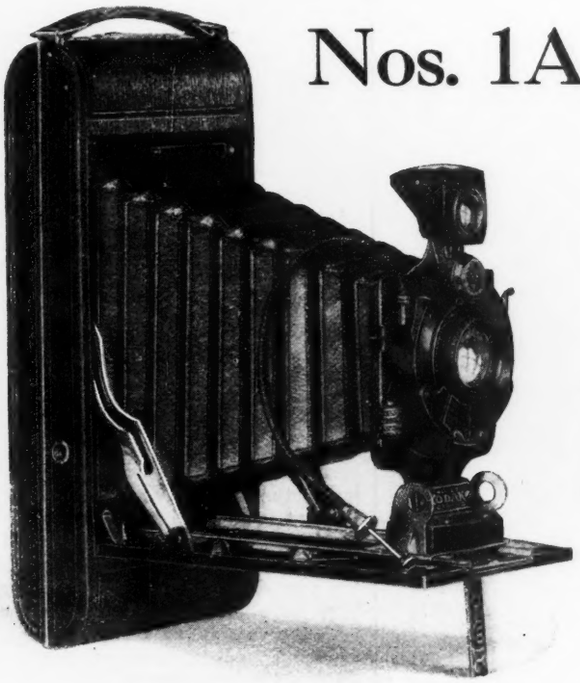


Holder for toolbits

The end of the bar is turned to a taper to fit the headstock or tail spindle of the lathe.

The same chuck also can be used in the drill press in conjunction with a fly cutter of the usual type.—G. L.

A new Kodak with a new shutter



Nos. 1A and 2C Kodaks Series III

Both models are equipped with the famous Kodak Anastigmat lens *f*.7.7 and the accurate Diomatic shutter.

Mechanically precise; Optically proficient

A fully-jeweled watch is corrected to one second but the Diomatic shutter must time up to 1/100 of a second—and it does. Fractions of seconds—1/10, 1/25, 1/50, 1/100—are clipped with greatest accuracy and this mechanical precision, together with the sharp-cutting Kodak Anastigmat lens *f*.7.7, makes good picture-making all the easier.

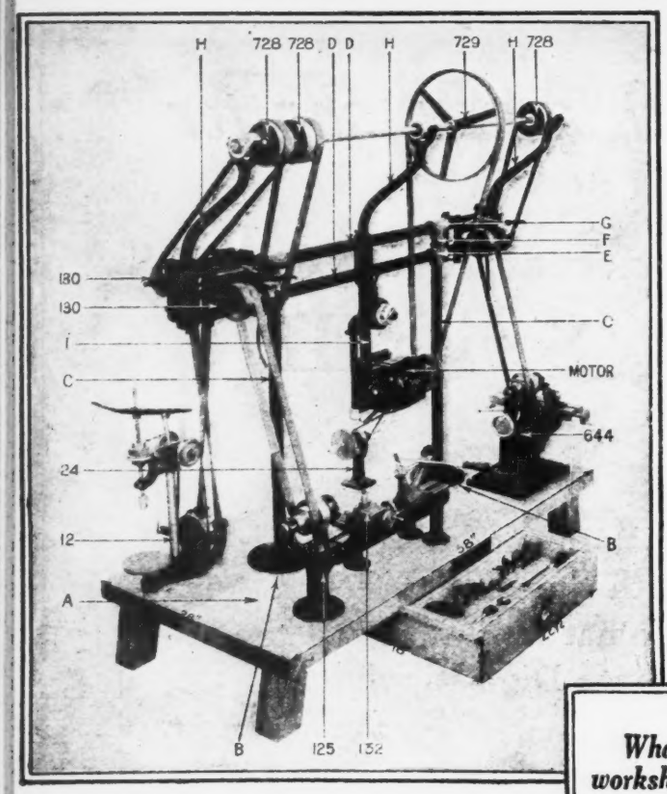
Additional refinements—the new quick action focusing device, the rising front and the automatic shutter dial, which points out the proper exposure under existing light conditions—combine to equip an unusually capable camera, at a conservative price.

PRICES

No. 1A Kodak, Series III, pictures $2\frac{1}{2}$x$4\frac{1}{4}$ inches	-	$30
No. 2C Kodak, Series III, pictures $2\frac{7}{8}$x$4\frac{7}{8}$ inches	-	33

If it isn't an Eastman, it isn't a Kodak

Eastman Kodak Company, Rochester, N.Y., *The Kodak City*



A motor-driven home workshop

that you can build yourself

If you have electricity you can easily build this motor-driven home workshop.

Then you can construct all the things you have always wanted to, in wood or metal, at a great saving in time. Do all the work yourself, save money and have loads of fun besides.

Starting with the bench, superstructure, and a one-quarter horse-power motor, you can build up this home workshop with the Goodell-Pratt tools listed at the right.

Send for free illustrated folder

Get all the details of this new popular home workshop. Find out how reasonably it can be installed. Free folder explains simply and clearly what to buy, the cost, and other details. A postcard will bring this folder at once.

Other tools for the amateur mechanic

In the Goodell-Pratt Catalog No. 15, you will find many tools, at low cost, that will help you do more and better work. Write for it. It's free.

GOODELL-PRATT COMPANY
GREENFIELD, MASS.

Toolsmiths
Makers of Mr. Punch

What this home workshop consists of:

(A) Bench, Dimensions 58" x 26" x 2" Legs 4" x 4".

(B) Super - Structure. Two cast-iron flanges 7' in diameter, 1¼" thick, bore 1" bolted to bench with four carriage bolts each 2¼" long.

(C) Two pieces of XX heavy 1" iron pipe 28" long threaded at both ends.

(D) Two pieces of 1" iron pipe 58" long.

(E) Two 1" crosses.

(F) Two 1" close nipples, double heavy.

(G) Two 1" T's, heavy duty type.

(H) Three offsets supporting jack forward, forged out by a blacksmith and offset forward approximately 12" and upward 10".

Motor. One-quarter horsepower, 1,700-1,800 revolutions per minute

(24) G. P. Polishing Head No. 24.

(12) G. P. Bench Drill, No. 12.

(125) G. P. Bench Lathe, No. 125.

(132) No. 132 Slide Rest.

(644) Milling Machine No. 644

(130) G. P. Countershafts No. 130.

(728) G. P. Aluminum Pulley No. 728.

(729) G. P. Aluminum Pulley No. 729.

GOODELL-PRATT

1500 GOOD TOOLS

Machining Troubles

(*Continued from page 90*)

operator was roughing out the hole with a core drill as shown at *A* in Fig. 3. As he found that the tool "walked around," following the cored hole, he put a large bar of steel *B* in the side head of the machine and used it as a support for the drill, but it did very little good. I was passing through the shop at the time, so I inquired, "What's the trouble, Archie?"

"Well, sir, this cored hole doesn't run true and I'm trying to use the side head to hold the drill from wabbling."

"Why don't you bore the hole instead of using a core drill?" I asked.

"Oh, that's too slow," he replied. "I can't get the work out fast enough that way."

So I told him to get a tool like that shown at *C* and set it so as to generate a true running hole, *D*, for a short distance in the hub of the casting, boring it about 1/64 in. smaller than the diameter of the core drill. He soon caught the idea and found that after the core drill had once been started in a true running hole, it followed the same direction very well and was not so greatly influenced by the irregularities of the cored hole as it had been previously. A single boring cut following the core drill and then a reaming operation gave an accurate hole concentric with the outside surface.

ANY time you have a job to do that is troublesome, first make sure that you know *the cause of the trouble*—then remove the cause and your job is half done.

"Chattering" is found in nearly all kinds of cutting, drilling, boring, turning, facing and milling operations, and sometimes it is difficult to find the cause of the trouble. It may be in the machine itself, in the work-holding device, or in the tools. If your machine spindle and various gibs are snug and tight, so that there is no chance for looseness here, you can eliminate the machine in looking for the trouble. If your method of holding gives ample support to the work and there is no spring to it, you can forget this also and make up your mind that the trouble lies with the tools themselves or the method of holding the tools.

Sometimes a very simple remedy can be applied, as in the case shown in Fig. 4. The work *A* was a steel ring forging about 7 in. in diameter that was to be faced at *B* and a recess cut at *C*. There were other operations on the work, but with these we are not interested.

THE piece was held in chuck jaws and a shovel nose tool *D*, having a 1-in. face and 1½ in. deep, was used for the recess. The tool was ground as shown at *E* and set ⅛ in. above center to give a slight shearing action to the cut. I had to feed the tool into the stock in the direction of the arrow *F*.

Unfortunately, the machine, a horizontal turret lathe, happened to be placed on the floor directly over the superintendent's office. As I started the job, hand feeding the tool into the work, it began to "chatter" very badly. I pulled it out and

(*Continued on page 98*)

"Wherever men depend upon cutting tools most"

You should use Simonds files because of their *teeth*—their sharpness and their hardness.

If you would have good cutting tools worthy of the task you assign to them, say SI-MONDS to your dealer. The Simonds organization has been producing cutting edges of tempered steel since 1832. You may be certain that a tool bearing the Simonds name is RIGHT — in materials — in design — in workmanship. But be sure to pronounce the name SI-MONDS.

SIMONDS SAW AND STEEL COMPANY

"The Saw Makers" Fitchburg, Mass. *Established 1832*

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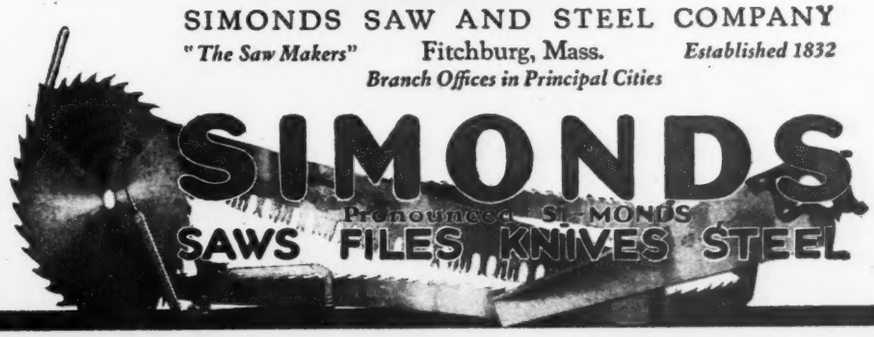

Columbia Hot Shot Batteries contain 4, 5 or 6 cells in a neat water-proof steel case.

Packaged Electrical Power

FOR long-lasting punch and pep on home, office, workshop and laboratory electrical tasks, use Columbia Eveready Dry Batteries. Press the button or throw the switch and they respond with lightning speed. Open the circuit and the Columbia Eveready rests easy, recuperating its force and restoring its energy.

Bells, buzzers, telephones and telegraphs come to vivid life at the command of Columbia Eveready Dry Batteries. Lights for dark places burn brilliantly. Gas engines putt-putt away without a miss when Columbia Eveready Dry Batteries furnish crackling hot sparks for ignition. Electrical experiments and tests are made easily when you have these good batteries on hand. Industrial and college laboratories use them when steady, unvarying voltage and amperage are needed for delicate work.

When you buy dry batteries, don't just ask for "a dry cell." Ask for "Columbia Eveready Dry Batteries" by name and get 100% battery efficiency. Columbia Eveready Dry Batteries are sold by electrical, hardware and auto accessory shops, implement dealers, marine supply dealers, garages and general stores. Columbia Eveready Ignitors can be purchased equipped with Fahnestock Spring Clip Binding Posts at no extra cost to you.

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EVEREADY
Dry Batteries
—they last longer

for—

Gas engine ignition	Motor boat ignition	Ringing burglar alarms	Firing blasts
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Doorbells	Tractor ignition	Calling Pullman porters	Running toys
Buzzers	Starting Fords		Radio "A"
	Protecting bank vaults		

Machining Troubles

(*Continued from page 96*)

tried again with about the same result, except that the superintendent came rushing up the stairs and wanted to know what I was trying to do.. Said I shook the whitewash off the ceiling all over his desk and made a few other remarks unnecessary to repeat.

I didn't want to lose my job and, of course, I saw that the "chatter" was caused by the tool springing and digging into the work. I pushed it back as far as I could into the holder, so as to have as small an overhang as possible, but still it chattered. Finally I took the tool out and with a pocket carborundum stone dressed it up on the end to form a narrow "land," as shown at *G*, just below the cutting edge. This land gave enough support to the cutting edge to prevent the tool from digging in. The chatter stopped at once and the tool thus dressed produced a good smooth surface.

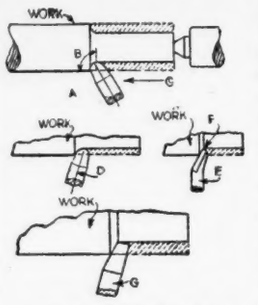


Fig. 7. Good and bad methods in turning

Too much overhang of tools is a frequent cause of chatter. In lathe work, long tools often are used as shown at *A* in Fig. 5. If the overhang is too great, the tool may deflect on account of the pressure of the cut, and by springing back into the work cause chatter. Under a heavy cut, even when the overhang is reduced to a minimum, there may be chatter, but sometimes this can be remedied by adding an extra toolpost, as shown at *B*, to give additional rigidity. By setting the tool a trifle below center, as at *C*, any spring to the tool causes it to deflect away from the work, as shown by the dotted line, and, therefore, it does not tend to dig in.

A "goose-neck" tool, as shown at *D*, also is very useful for wide cuts or for forming cuts, and this type of holder prevents chatter by allowing the tool to spring away from the work without digging in.

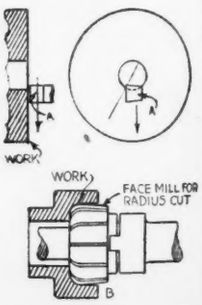
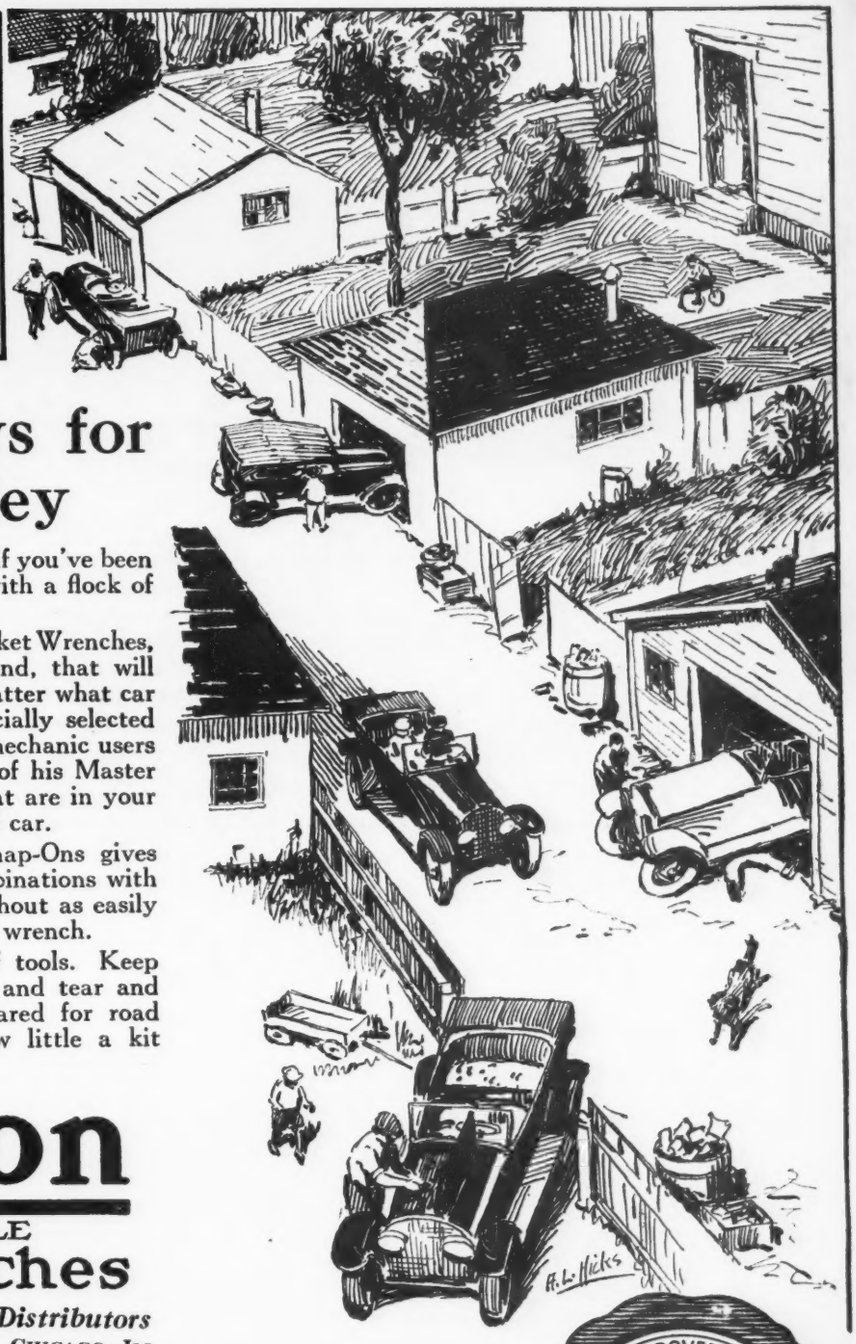


Fig. 8. Facing and bottoming operations

I once had a number of long slender shafts to rough turn, as shown at *A* in Fig. 6, and, following the usual practice, I turned a spot on the shaft and applied a steady-rest at *B*. When I started feeding the tool in the direction of the arrow, a chatter became apparent at approximately the point *C*. This chatter increased for a short distance and then gradually diminished as the tool approached the steady-rest. This was doubtless due to a slight amount of vibration between the steady-rest *B* and the headstock.

(*Continued on page 100*)



Welcome News for Gasoline Alley

THIS will sound mighty good to you if you've been worrying along in Gasoline Alley with a flock of assorted style and misfit wrenches.

You can now have a kit of Snap-On Socket Wrenches, the tools mechanics use and recommend, that will service your car in garage style. No matter what car you drive your Snap-Ons will be especially selected for your use. Any one of the 200,000 mechanic users of Snap-On Wrenches would pick out of his Master Service Set the same identical tools that are in your kit for work on your particular make of car.

The interchangeable principle of Snap-Ons gives you in a handful of units, wrench combinations with which you can service your car throughout as easily as you can take off rim nuts with a rim wrench.

Decide now to own this real set of tools. Keep your car tightened up—prevent wear and tear and replacements of worn parts—be prepared for road emergencies! You'll be surprised how little a kit of Snap-On will cost you.

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INTERCHANGEABLE Socket Wrenches

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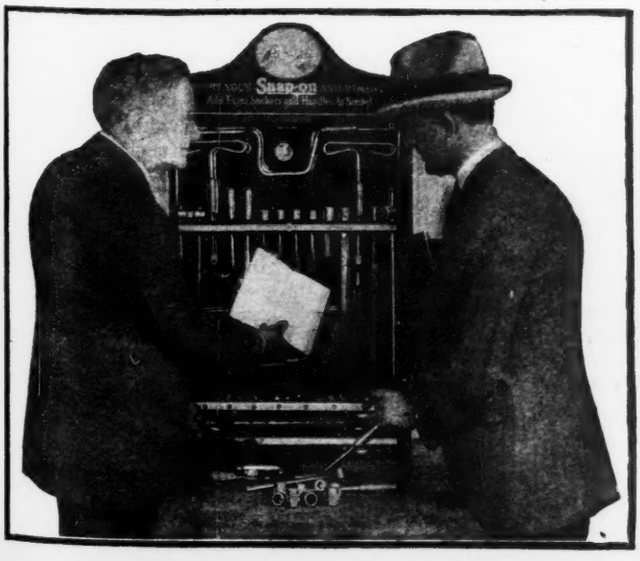

The dealer who has this Snap-On Cabinet is a socket wrench expert. He can tell you anything you want to know about 'em—supply you with the right wrenches for your car or for any other purpose. Fill out and mail the coupon today.

APPROVED BY POPULAR SCIENCE INSTITUTE OF STANDARDS

Snap-On Interchangeable Socket Wrenches have been approved by an impartial authority—Popular Science Institute of Standards.

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CHARGING a storage battery ten years ago was a task needing expensive apparatus and the services of a specialist. Today, anyone can do it in the home. No knowledge of electricity is needed. It can be done economically, simply, automatically with

The New Silent GOLD SEAL HOMCHARGER

just as more than 200,000 satisfied users of Homchargers are doing right now.

If you are one of the many who envy the results of storage battery tubes but think you can't enjoy them unless you are a battery expert, go right out now and buy those tubes, a battery and a Gold Seal Homcharger.

Here's all you have to do to maintain a storage battery: add a little water once in a while (your eye will tell you when); charge it regularly. To use the Homcharger, screw a plug in any lamp socket, slip two spring clips over the battery terminals, go to bed and forget about it. Next morning the battery is charged. What could be easier?

The Gold Seal Homcharger: simple, efficient, dependable, quick. Cannot injure battery, furnishings, anything or anybody. Handsome, finished in mahogany-red and gold. Approved by Fire Insurance Underwriters. Unqualifiedly guaranteed. Only one moving part, replaceable for $1 after thousands of hours of use. Silent: its faint hum cannot be heard in next room.

Popularly Priced: buy it at your dealer's for $18.50 complete; $25.00 in Canada. For radio at its best, use storage battery tubes, any good battery and the Gold Seal Homcharger.

FREE! Send for our interesting free booklet, "The Secret of Distance and Volume in Radio," containing valuable information on this subject and fully describing the GOLD SEAL HOMCHARGER.

THE AUTOMATIC ELECTRICAL DEVICES CO.
131 WEST THIRD STREET, CINCINNATI, OHIO.

Largest Manufacturers of Vibrating Rectifiers in the World.

IS

Machining Troubles

(*Continued from page 98*)

I removed the steady-rest and set up a follow rest, as shown at *D*, and still found more or less chatter, which was most pronounced near the tailstock and gradually diminished as the tool approached the headstock, finally ceasing altogether about as indicated in the diagram. This had me puzzled for a while, for the marks on the shaft took the form of a long, gradually diminishing group of spiral lines of constantly changing pitch, but finally I made up my mind that the peculiarity was caused by torsion in the work. The farther away the tool was from the point where the shaft was driven, the more flexibility there was in the shaft, so that the resistance of the work to the tool and the twisting of the shaft caused the trouble. The only remedy was a finer feed combined with higher speed. I have recently seen a much more pronounced case caused by reducing with a special three-tool hollow mill a 2-in. shaft to 1 in. diameter in a single operation with a very coarse feed.

MANY men like to use a round-nose tool for roughing stock, but such tools often chatter because of so much surface in contact with the work. I saw a man in the factory the other day roughing down a bar of stock with a round-nose tool set in the toolpost as shown at *A* in Fig. 7 (page 98). Of course, the arc of contact with the work was a quarter circle, as indicated at *B*. The tool was being fed in the direction *C* and, therefore, the natural pressure tended to throw the tool into the work. The way in which the tool was set and the action produced on it reminded me of a man walking along the sidewalk pushing a cane before him. It is evident from the diagram that this is a very bad way to set up a tool.

If you *must* use a round-nose tool for this kind of work, set it up as shown at *D*, so that the pressure of the cut will throw it away from the work and not into it. Some men use a side tool, as shown at *E*, for roughing down a piece of stock. They give it a slight round on the point *F* so that it will not leave a surface too much like a thread and also so that it will stand up better. This will answer very well for large stock reductions by using a very fine feed and comparatively slow speed.

A better way, however, is shown in the diagram at *G*, as a heavier feed can be used with this type of tool. It is best to set the tool on center or slightly below it; it should never be set above center.

In facing a steel forging or casting, a wide tool often can be used to advanatge with a comparatively coarse feed, as indicated in Fig. 8, if you set the tool from ⅛ to ¼ in. below center, as indicated at *A*. This gives a better cutting action because the metal is removed by a shearing cut. Any tools used for facing cuts will remove metal faster and produce a smoother surface if a shearing cut can be used. A face mill, for example, having teeth ⅛ in. ahead of center will do better work than one with teeth cut on center.

I remember a facing job on malleable iron where I had occasion to use a face and bottoming mill on a turret lathe, as

(*Continued on page 102*)

This $15,000 Electrical Home —free

INTERNATIONAL PRIZES

FIRST PRIZE—

$15,000 Model Electrical Home

(To be built on lot provided by winner)

TWO SECOND PRIZES—1 Boy—1 Girl

$1200 scholarship in American or Canadian College or University of accepted standard.

TWO THIRD PRIZES—1 Boy—1 Girl

$600 scholarship in American or Canadian College or University of accepted standard.

TWO FOURTH PRIZES—1 Boy—1 Girl

$600 scholarship in American or Canadian College or University of accepted standard.

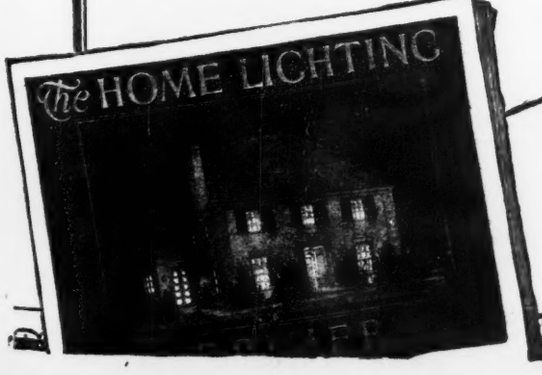
TWO FIFTH PRIZES—1 Boy—1 Girl

$300 scholarship in American or Canadian College or University of accepted standard.

TWO SIXTH PRIZES—1 Boy—1 Girl

$300 scholarship in American or Canadian College or University of accepted standard.

REMEMBER: To compete successfully in the Home Lighting Contest, your child must obtain a copy of this "Home Lighting Primer" from your local electrical people.



Have your child go to the local electrical club or league, or to the office where you pay your electric light bills and get free, the "Home Lighting Primer."

—It tells how to win this $15,000 electrical home or a college scholarship, contains a complete illustrated series of simple lessons on better home lighting and fully explains both the local and the international phases of the Home Lighting Contest activity.

Watch for the announcement of the essay contest in your town. — Any school child, ten years of age or older, may compete.

Better Light—Better Sight

The Home Lighting Contest is designed to teach the public, particularly the young generation, more about electric light, and how in their daily lives to properly use it so that in future years there shall be less eye trouble and better general health. This activity has the support of our leading educational and health authorities.

Your Local Electric People Will Help

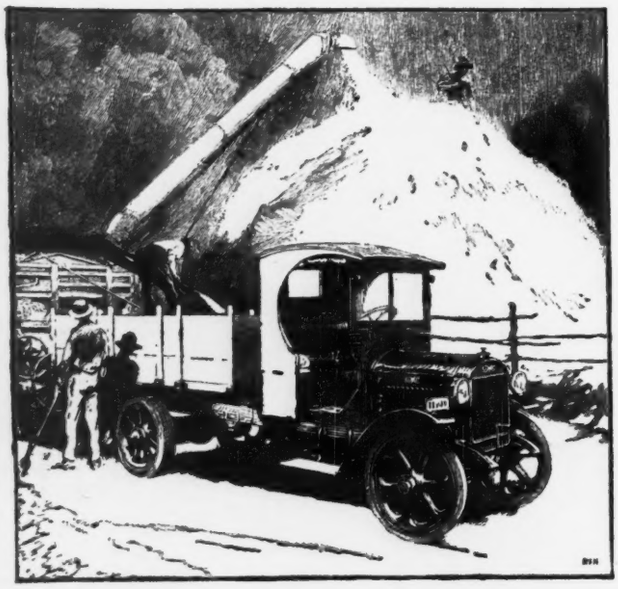
The Electrical League or Club, or the Electric Light Company serving you, will gladly enter your children in the Home Lighting Contest, supply them with the "Home Lighting Primer" and tell them what to do. There will be local prizes, and the winning children will be contestants for the international prizes—the $15,000 electrical home and the university scholarships.

Be sure that your children enroll for the essay contest as soon as it is announced in your city or town. Watch your home paper.

HOME LIGHTING CONTEST

The LIGHTING EDUCATIONAL COMMITTEE

680 Fifth Avenue · · · New York, N.Y.



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The Guarantee of Better Haulage

Ownership of a GMC truck is a guarantee of uninterrupted, economical haulage.

Not alone because GMC trucks are built of the finest materials—

Not alone because they embody exclusive features of design that make them operate cheaper, wear longer and that allow every wearing part to be renewed indefinitely—

Not alone because their list price is lower and represents the actual cost of building plus a fair profit only—

Not because of any of these individually, but because together, they provide every quality essential to profitable trucking.

GENERAL MOTORS TRUCK COMPANY
Division of General Motors Corporation
PONTIAC, MICHIGAN

GMC

General Motors Truck Co.
Pontiac, Michigan
Department 47

Gentlemen:

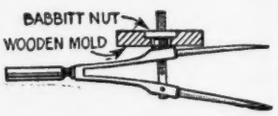
Please send me further information. I am interested in a (truck) (dealership).

Name .....

Address .....

Stripped Drafting Instrument Nut Replaced with Babbitt

ABOUT four years ago, when the nut on my bow dividers wore out, a friend suggested that I pour a new nut out of hard babbitt. We made a small wooden mold as shown and poured the



Wooden mold is used in casting a new nut

babbitt around the screw. A little coaxing loosened the babbitt from the screw, and the nut so made has been in use ever since.—F. N. C.

Driving Nuts Rapidly

RECENTLY we had a large number of bolts on which the nuts had to be driven close up under the heads. As the cost of screwing them up by hand was prohibitive, a driving tool was made as shown. With this we completed the work in a short time.

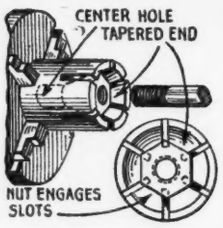


Diagram holder for hex nuts

The tool is a bushing, which first was drilled out to clear the bolt. The outer end of the bushing then was bored to a 90-degree taper. Six slots were cut, as indicated, and the bushing was held in the chuck of a lathe.

In use, the nut was started on the bolt by hand, and then held against the slotted part of the bushing, which causes it to turn with the chuck.

When square nuts are used, it is necessary to use a bushing with only four slots.—R. H. KASPER.

Machining Troubles

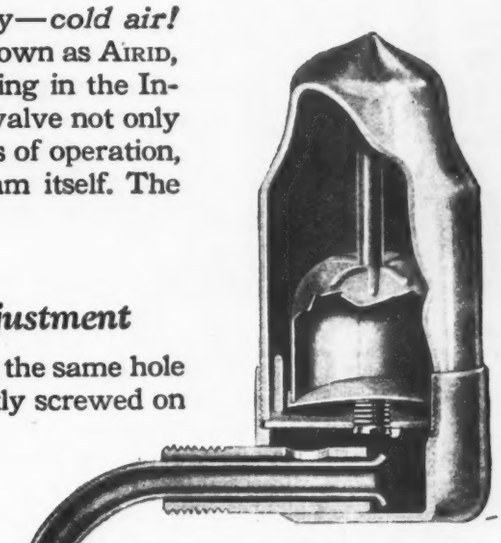
(*Continued from page 100*)

indicated at *B*. The mill was about 3 in. in diameter and had 12 teeth cut on center with a 3/8-in. radius at the end. The hole previously had been bored and rough faced and there was no trouble about these operations, but when it came to the final facing and cutting of the radius, I found it almost impossible to make the mill take hold, even with all the pressure I could apply to the turret-feed hand wheel. All I could get was a scraping action, producing the chip in a fine powder, and an occasional chatter.

I put my wits to work and decided that the mill would not cut because each tooth had nearly 1 in. of surface in contact with the work, 12 in. for all the teeth, equivalent to a cut nearly as wide as this and requiring more pressure than I possibly could apply to the hand wheel. I took out the mill and ground away the cutting edges on every alternate tooth, leaving only 6 cutting teeth. After doing this I had no further difficulty, as the mill cut freely and gave a smooth finished surface. I have had a similar experience since that time with other tools and the experience gained on this one job has helped me materially on others.

Clever mechanical contrivance makes cold radiators HOT

AT LAST steam has conquered its greatest enemy—*cold air!* A newly perfected and improved *air valve,* known as AIRID, has been produced after many years of experimenting in the Institute of Thermal Research at Buffalo, N.Y. This valve not only rids steam radiators of cold air under all conditions of operation, but automatically prevents the escape of the steam itself. The result is hot radiators.



Installed by anyone in 2 minutes —and works without adjustment

No tools are needed to install AIRID. It is made to fit the same hole provided for old-fashioned air valves, and is tightly screwed on in a few seconds.

After that, it need never be touched. There is nothing to adjust and no one can tamper with it. AIRID works automatically and permanently to keep the radiator hot.

Why many radiators are half cold

Coming up from the boiler, steam pushes cold air ahead of it. Unless the air can get out, it fills the farther end of the radiator, and acts as a wall to keep back the steam. Hence many good radiators are continually half cold.

If you examine AIRID closely, you will notice a tiny hole at the very top of its nickel-plated cone. Out of this hole the air can pass freely, until the radiator is full of hot steam. But this is only half the story.

Almost human intelligence

The moment that steam fills the radiator and enters AIRID's inner chamber, a remarkable contrivance shuts the door of escape, and holds back the steam. This operation is controlled by a sensitive little float which expands under the heat of steam, and forces a pin up into the vent-hole—making the valve absolutely tight.

Water, always present in steam pipes, will very often get into the chamber of the air valve. This menace has been foreseen and provided for: the float rises on the water and immediately shuts the vent. A glance at the illustration of AIRID will show you the ingenious syphon-pipe which draws the water back into the radiator. Because the valve chamber is free from water, the path of escape is always open for cold air.

SEND COUPON *with $1.60 and watch* AIRID *work*

AIRID is guaranteed by the American Radiator Company. The only way to appreciate how different it is from all other air valves is to see it work. Try it on your coldest radiator; transform your chilliest room. Fill in the coupon, attach $1.60, and your first AIRID will come to you by return mail. Your heating contractor can sell you more AIRIDS at the same price, after this one has demonstrated its magic power to make a cold radiator *hot.*

Made and guaranteed by the

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So vital a factor has the telephone become in American life that the demand for it would undoubtedly grow even without increases in population. New businesses are founded; others expand. New homes are established in town and city, in suburban dwellings and apartment houses.

To meet the needs of America, to-day and to-morrow, with the best and cheapest telephone service, is the responsibility of the Bell System. The telephone will grow with the population and prosperity of the country, and the plans of to-day must anticipate the growth of to-morrow.

The service which is given to-day was anticipated and provision was made for it, long in advance. Money was provided, new developments were undertaken, construction work was carried through on a large scale. The Bell System, that is, the American Telephone and Telegraph Company and Associated Companies, has continuously met these requirements. It has enlisted the genius of technical development and the savings of investors for investment in plant construction.

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428 pp. 248 Illus. $3.00

Popular Science Monthly
250 Fourth Ave. New York City

How to Solve Milling Problems with a Dividing Head

(*Continued from page 92*)

When the index head is connected by suitable gearing to the feed screw of the table, the movement of both will be positive and a cutter in contact with the work will cut a spiral or helix around the circumference of the cylinder.

The gearing to do this class of work is found in tabulations provided with the machine. The table is swiveled to the angle given for the helix angle clearance, right or left, depending upon the spiral being cut. Each successive cut must be indexed by hand as for plain indexing; this is governed by the number of divisions or teeth to be cut.

When a spiral is being cut, the index plate rotates with the work. It should be held stationary when indexing the teeth and the cutter brought back to the starting point before turning for the next cut. To do this, drop the back lock pin into place while turning the crank and release it before starting the cut.

THE principle of milling spirals is based upon the relation of the lead or pitch of the spiral to be cut with the lead or pitch of the feed screw of the table and it always signifies the distance the table will advance in one revolution of the index head spindle. Leads from about ¾ in. up to 60 in. can be cut with the average index head. For special leads it is sometimes necessary to provide special gearing or use compound gearing. Spiral milling is confined mostly to the grooving of cutters, reamers, twist drills, taps, spiral gears, and similar work.

Figure 5 shows a cam milling job. In this work the head is geared the same as for spiral milling when the cam has a uniform or constant rise, and the lead can be varied by changing the angle of inclination of the head. The cam is always turned back to the starting point for each new cut in order to keep the back lash in one direction all the time. When possible, set the cutter to mill on the under side of the cam. Tabulations usually are furnished for finding the correct gears and angles for various cam rises or leads.

Differential indexing is used to extend the range of divisions beyond the limits of the available index circles on the plates. It is about the same in principle as compound indexing, but it cannot be used for spiral milling work. More than 2000 divisions are possible with this system, whereas 380 is about the limit when using the index plates. Differential indexing is accomplished through a combination of gearing whereby the spindle of the index head is geared to a worm wheel shaft and connected with suitable idler gears. This system can only be used with the head in a horizontal position, as it requires a gear on the spindle.

Some milling machine index tables are very complete and contain all the necessary information in regard to placing the gears in the right place, and generally illustrate one or two examples of typical problems. When there is no gear indicated in any of the columns of the table, the indexing is plain. Where gears are

(*Continued on page 106*)

LOOK FOR THIS STAMP—"GEO. S. PARKER—DUOFOLD"—AND DON'T LET IMITATIONS DECEIVE YOU

Pull a Good One

When You Write—or Lend

A Pen You Need Not Apologize For
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PULL a good one—meet the world on even terms. For today Parker Duofold is the pen with which Success associates—it's replacing old pens, thousands per day.

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Not only this, they bring to the hand that speed and character which win with the world. And wherever you carry this black-tipped lacquer-red beauty it evokes admiration and respect. A color that makes it a hard pen to lose—an Over-size barrel which holds that extra ink that is just like money in the bank when you need it.

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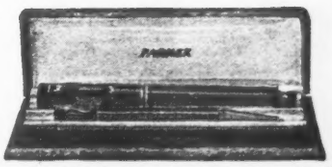

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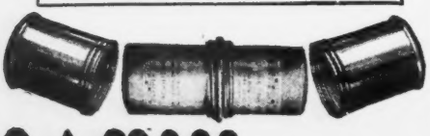


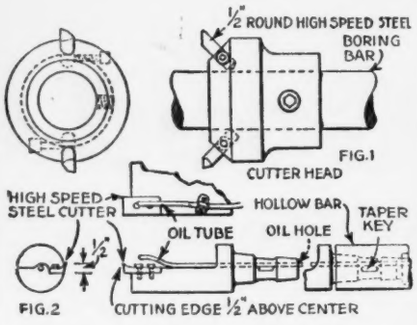
Williams
Doublecap Shaving Stick

By the makers of the famous Williams Holder Top Stick, and Williams Shaving Cream with the Hinge-Cap

Two Boring Tools that Aid in Heavy Work

FOR boring large cored holes with a horizontal boring machine, the tool shown in Fig. 1 is well adapted. It is provided with two high speed toolbits, held in place by setscrews. This holder may be drilled to receive four tools, if desired, as in many cases two extra tools will do better and faster work.

The holder should be a sliding fit on the bar and fastened with a setscrew. Place a piece of round brass under the setscrew so that the bar will not be marked. If the tool is to be set to a certain size for duplicating the same hole in many castings, the



Tool for boring large cored holes and a "hog-nose" drill for deep holes

cutters may be set and ground to the required size in the grinder.

Figure 2 shows a design for a deep hole drill, or "hog-nose" drill, as it is sometimes called. The body, including the shank, is made of cast iron for holes of large diameter. For holes up to 3 in. steel may be used.

A pocket is milled in the front left-hand corner to receive a high speed steel cutter, which is fastened to the body with two cap bolts. An oil tube is fitted to the body to supply oil to the cutter when working in steel.

For unusually long holes a hollow bar is used and the oil is pumped through the bar. Where a solid bar is used, a groove is cut on the outside of the bar to receive a ¼-in. brass or copper oil tube.

The body diameter of this type of drill should be about .010 in. smaller than the diameter of the hole. The cutter is ground for size in place and on centers, and is relieved for side clearance.

Solving Milling Problems

(*Continued from page 104*)

shown, the indexing is differential or compound; for this, all that is necessary is to find the gears having the number of teeth indicated and place them in their proper place as shown, select the correct index circle, and index with the crank as in plain indexing.

The use of the universal index head covers a great variety of work and is capable of solving many intricate problems in tool and jig making. It is one of the most interesting and absorbing devices found in the shop and is worthy of the best attention and study of enterprising young mechanics. And when once its fundamental principles are understood, it will be no longer just a box of mysteries.

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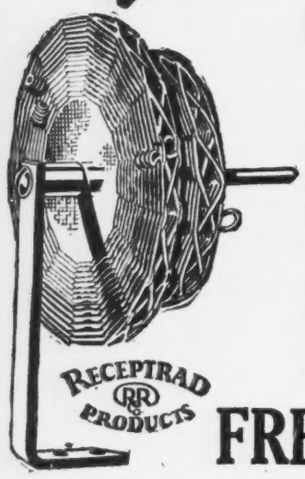

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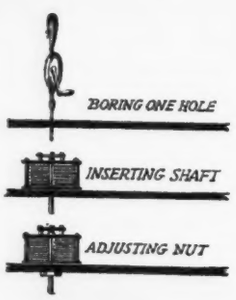

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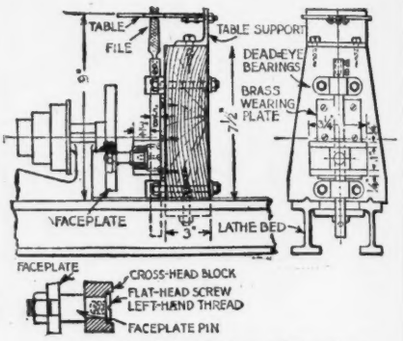
Filing Costs Cut by Use of Lathe Attachment

By Frank N. Coakley

WHEN much filing is to be done in a small shop, the homemade filing machine illustrated will be found a great saver of time. It is designed to be driven by a lathe, and the construction is simple, strong, and inexpensive.

The main body is a piece of oak 3 in. thick, 7½ in. wide, and of a length to suit the width of the lathe bed. The crosshead is made from a piece of 1½ by 1⅜ in. steel, 3¼ in. long. This block is slotted as indicated to allow the crosshead block to slide in it, and it is also slotted on the opposite side to fit a ⅝-in. square bar. This bar, which is fastened securely to the crosshead, is turned down to ⅝-in. diameter at both ends to allow it to slide in the two solid "dead-eye" bearings, which are standard bearings and can be purchased at low cost. The bearings are



Front and left-hand views of the filing machine, and detail of faceplate pin

fastened to the wooden body with through bolts.

The upper end of the ⅝-in. bar is drilled to receive the end of the file, which is held in place by two small setscrews. Back of the crosshead and fastened to the main body is a brass plate against which the crosshead slides.

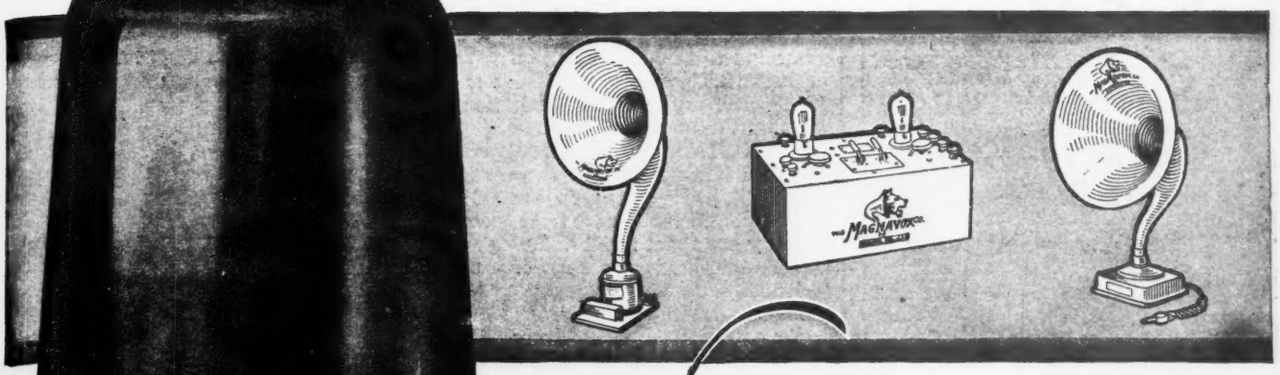
To support the table a piece of 2 by 2 by ½ in. angle is fastened to the top of the body with two lagscrews. A ½- or ⅝-in. hole is drilled near the top of the vertical leg of the angle.

The table is a piece of 3/16- or ¼-in. plate smoothed and polished on the upper surface. A slot is provided to allow the file to pass through. To the under side of the table a three-cornered piece is riveted with countersunk rivets. A round extension projects from one side of this piece and is threaded so that it can be fastened with a nut to the table bracket. This arrangement allows the table to be tilted.

The machine is fastened to the lathe bed with a hanger screw and a piece of flat plate.

The stroke of the machine as shown is 2 in. A longer or shorter stroke may be obtained by moving the faceplate connection in or out. If a much longer stroke is used, the bearings will have to be farther apart.

THE best method for locating holes accurately in jigs and dies will be explained in an article by H. L. Wheeler, scheduled for early publication.



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MAGNAVOX RADIO VACUUM TUBE TYPE A is a storage battery tube for use as audio frequency and radio frequency amplifier in all standard circuits. Highly recommended also for detector use. This tube is not critical of adjustment either as to plate or filament. Filament consumption one quarter of an ampere.

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Unlike the ordinary storage battery tube, Magnavox Tubes give the electrons an unobstructed passage between filament and plate, with the result that the Magnavox has less than one half the internal capacity of other tubes of similar type.

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TRIMO

The Pipe Wrench

For Men Who Love Fine Tools

In Steel Handle—All sizes from 6" to 48".

In Wood Handle—6, 8, 10, and 14 inch sizes.

It's good to grip a TRIMO. You feel ready for any job, it's such a finely built, powerful, capable wrench.

Here are some of the reasons why Popular Science Institute of Standards endorses the TRIMO and why you'll find it one of the best tools a man can own:

Drop-Forged jaw and handle and pressed steel frame that does not break.

Strip-Proof Threads in nut and in movable jaw, rounded top and bottom, guaranteed not to strip or burr.

Nut Guards to keep adjustment perfect when working in close quarters.

Insert Jaw in handle. Can be readily replaced when dull or worn, making the TRIMO the most economical wrench, since it lasts longest.

You'll find the TRIMO Pipe Wrench one of the most serviceable, likeable tools you've ever used.

Ask your dealer for a TRIMO. Accept no substitute.

NOTE: When you need a Monkey Wrench, Chain Wrench or Pipe Cutter ask to see a TRIMO and judge for yourself as to quality and value.

7106

TRIMONT MFG. CO.
ROXBURY, MASS.

How to Fit New Piston Rings

By Ray F. Kuns
Author of "Automotive Trade Training"

"MY OLD 1917 bus runs like a top since I put in those new rings according to the directions you gave me last month," said a friend the other day. "Several of my neighbors had tried new rings that did not seem to do much good. I hunted all over town and finally did find them. I had to get .007 in oversize on the width, as the ring grooves were worn tapered, and I had a time to fit them, but I finally got them fitted and now I have to keep the brakes on most of the time to hold the old wagon."

This literal repetition of the owner's statement tells the whole story. Here is an owner who likes to maintain his car in good running condition by doing his own repair work. His equipment is that of the average home garage; his problem that of fitting new rings into piston grooves worn tapered by long service. In the service garage, it is likely that the pistons would be discarded in favor of new ones, and rightly so. At least the ring grooves would be trued up in a lathe or with a special tool.

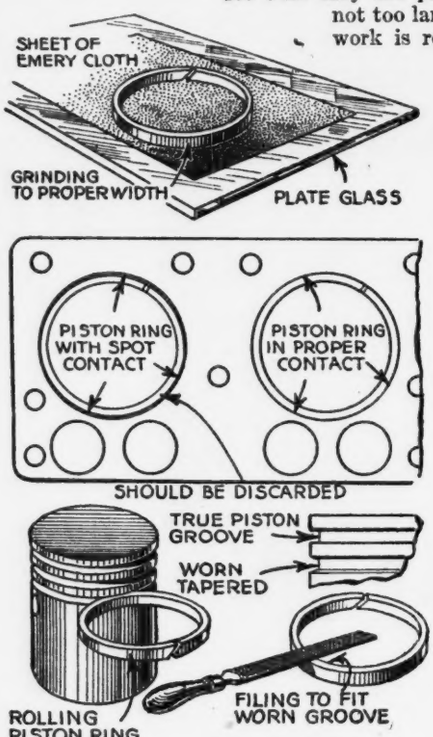
The first thing this owner did was to find the rings he needed. It is easy to find rings having the proper oversize when considering cylinder diameter, but a bit harder to find the ones with the oversize on the width, and in this case, that was absolutely essential. Having the rings, he then proceeded to fit them.

The most important consideration in fitting rings is to have a ring that lies in perfect contact with the cylinder walls. The next is to have a ring that fits the piston groove, and the third consideration is to have a ring in which the end clearance is not excessive. There are others, but if these three have been met satisfactorily, the owner is reasonably sure of a satisfactory job.

First, remove the pistons and connecting rod assembly, being careful to maintain all shims and bearings in order. Next, use three thin strips of steel to slip under the rings and slide them from the pistons—hacksaw blades or old case knives do nicely. Remove all carbon deposits from the piston-ring grooves and clean thoroughly. Inspect the rings and grooves for evidences of wear. If the grooves are worn tapered, have them trued up on a lathe or with a piston-groove cutting tool, or, failing this, observe the instructions given in detail below for filing to a fit.

Estimate the oversize of the cylinder diameter. Unless previously rebored or reground, this may run from .005 to .010 in. Use a feeler gage to learn the amount of wear in the piston-ring groove; the top one usually has most. From these figures order the rings. As to what type of ring to purchase, that is largely a matter of personal opinion—one piece, two piece, or three piece; bevel, step, or patented joint—the success of the rings rests in the three points mentioned above.

With the rings at hand, test them to see that they are properly oversize and not too large, or that too much work is required and a fit is impractical. Knowing that they are the proper size, they are fitted to the cylinder they are to be used in. This means filing the end joints until the proper clearance is obtained. When testing the ring in the cylinders, hold a drop-light under them and note if they lie in even contact with the cylinder walls. If they do not, it is useless to attempt to fit them.



Grinding a ring, testing it for width and concentricity, and filing it to fit the groove

While rings may be lapped to a fit with the cylinder walls, that is not always advisable. The best fit is secured when a lathe-finished ring has been properly peened or has proper tension to fit the cylinder walls at first hand. When the rings lie against the wall properly, the ends are filed to allow proper clearance between them. The top ring has .002 in. allowed for each inch of piston diameter; the lower rings half this amount. Next, fit the ring to the piston-ring groove, fitting individual rings to individual grooves, and maintaining them in that position.

The first step in fitting rings to grooves is to roll the ring around the piston with the outer edge of the ring in the groove. If the grooves are true, practically all the fitting may be done in this fashion.

Where the grooves are tapered, the first step is as above, and if the ring should be too wide, reduce it by means of a piece of emery cloth laid on a piece of plate glass or other true surface until it just starts to enter the groove. With a file, carefully reduce the inner edges of the ring until the ring is tapered to fit the

(*Continued on page 112*)

Make the World of Music Yours

WHEN a famous soprano sings the Gypsy Song from Carmen, hear it in your home exactly as she sings it.

Through MUSIC MASTER, the musical instrument of radio, let her voice be crystal clear. MUSIC MASTER gives to radio life and beauty, lending a wholly new charm to the wonders of the air.

MUSIC MASTER is not just a loud speaker —it is a *true* speaker, a *clear* speaker, a pleasing musical instrument.

Radio impulses entering the sensitive precision instrument in the base are translated into sound waves, undistorted and faithful to the original voice or instrument. In the tapered tone chamber of cast aluminum these sound waves grow clear and bell-like and, finally, the full, mature tones pour forth in rich resonance through the MUSIC MASTER amplifying bell of natural wood.

Your dealer knows. Have him send you a MUSIC MASTER to be proved with your own set.

Dealers Everywhere

Music Master Corporation

Makers and Distributors of High-Grade Radio Apparatus

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Music Master
RADIO REPRODUCER

Connect MUSIC MASTER in place of headphones.

No batteries required. No adjustments.

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It files everything, sharpens anything, with its two faces—double-cut (coarse) on one side; single-cut (fine) on other side. Two files in one.

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All-Work* File

with sheath

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Handle, forged as part of file, fits your hand, guides your stroke, saves your knuckles, makes work easy.

Carry a Plumb All-Work File in your kit or in your pocket. Sheath comes with every file, to protect the teeth from damage or rust.

You want this file for every job around the house, for your radio, to sharpen your knives and your tools.

The better hardware merchants, who sell the latest good things, have Plumb All-Work Files for you.

Only

35c *at your dealer's or by mail*
(40c west of Rocky Mts.)

It's no trouble to supply you if your dealer can't. Just send 35 cents and we'll see that you get your Plumb All-Work File by the next mail. Your money back if you want it.

FAYETTE R. PLUMB, Inc.
4810 James St., Philadelphia

Illustration of file, actual size

PLUMB
DOUBLE LIFE
Hammers Hatchets
Files Sledges Axes

How to Fit New Piston Rings

(Continued from page 110)

taper of the ring groove. To test the fit of the ring it will be necessary to slip the ring onto the piston in its natural position rather than by the rolling process.

Make quite certain that the piston ring will go into the groove at every point a distance to allow it to come flush with the outside of the piston. In all cases this must be looked to, or scored and frozen pistons and cylinder walls will result. In fact, it is well to measure the thickness of the new rings and compare it to the depth of the groove before starting work. There should be at least .005 in. back of the ring and .001 to .002 in. clearance in the ring groove.

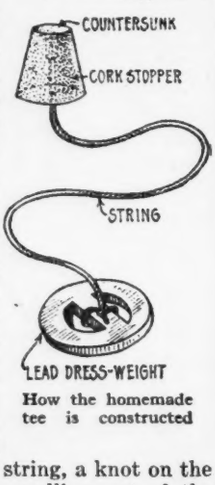
In final assembly it is well to go over all parts and clean thoroughly. Apply oil generously and assemble. If the car is to remain a considerable time before starting, introduce new oil into each cylinder to be certain of immediate lubrication.

When the engine is first started, run it on the floor with a line of hose to the radiator to keep it cool. See that the oil pump starts immediately (if a pump is used) and have plenty of oil in the engine. Place a pint of oil in the first five gallons of gasoline, and while the engine is running in, squirt a gunful of oil into the air intake of the carburetor each 10 or 15 minutes. After two or three hours' running, the oil should be drained and new oil used. Drain again after from 200 to 300 miles and after each 500 thereafter.

Cheap Captive Golf Tee

MOST golfers who use a captive golf tee have to buy a new one every few weeks. They either are left behind on the tees or are broken.

Although they generally cost less than a dollar, some golfers who are thrifty and like to make things may be glad to learn how to provide themselves with tees that cost practically nothing.



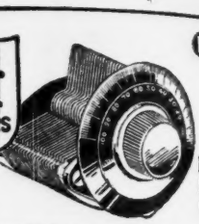
How the homemade tee is constructed

As will be seen in the accompanying illustration, the tee is made from an old cork stopper, a lead dress weight, and a few inches of string.

The small end of the cork is countersunk to afford a better seat for the golf ball. A small hole is made for the string, a knot on the end keeping it from pulling out of the cork. The other end of the string is tied to the dress weight, and the captive tee is finished.—F. S. ROOT, Fall River, Mass.

HOME WORKSHOP features scheduled for early publication include: How to Duplicate an Early American Arm-Chair, Lighting the Attic, What You Can Do with a Vise, Timing Auto Engine Valves, A Simply Constructed Smoking Stand, How to Make Rush- or Flag-Bottom Chair Seats, Duplicating Cheaply an Expensive Fireplace Screen, A Handy Spice Cabinet, Secrets of Varnishing Furniture Successfully.

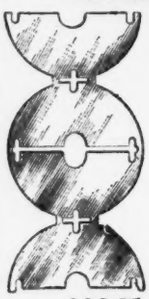
U.S. TOOL CONDENSERS
TRADE MARK



Point Number One

ONE PIECE STATOR

One of Several New Features in Four New Types



Stamped out of one piece of aluminum—the one piece stator eliminates broken contacts and soldered joints. Positive results—no leakage. Found in types 3 and 4, celoron end plates, and types 5 and 6, low loss—metal end plates.

Ask Your Dealer to Show You the One Piece Stator and other Improvements.

100% Guaranteed
Write for Literature

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127 Mechanic Street, Newark, N. J.
Mfrs. of Special Tools, Dies, Jigs, Automatic Machinery and Sub Presses.

—it's So Handy

YOU will say so just as others have as soon as you see the Simore screwdriver or combination knife and screwdriver. Model No. 11 has three screwdriver blades, No. 12 has a fine steel knife blade and two screwdriver blades. Both tools unusually useful around the house or car, or on a camping trip.

Blades are selected and produced by gravity action thru the chuck, and cannot be lost, or misplaced. When in place for use the blades are rigid and dependable. Handle blued to prevent rust.

Model No. 11 for $1.80, and No. 12 for $2.25. Send money order or your check and we will ship post prepaid at once. Each tool guaranteed, and your money refunded if not satisfactory.

Dealers are requested to write for information on these tools and the Simore Automatic Try square.

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"Saws in the Shop," "Saw Sense," "Saws on the Farm." Just send us your name and address and say which of these helpful books you want—Free. Write NOW.

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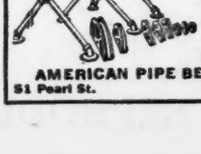

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HAND and MOTOR OPERATED
14 Sizes of Machines
What it costs to bend pipe our way. Per bend.
1" pipe 5 cents 4" pipe 25 cents
2" pipe 10 cents 6" pipe 60 cents
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Send for Catalogue.
AMERICAN PIPE BENDING MACHINE CO.
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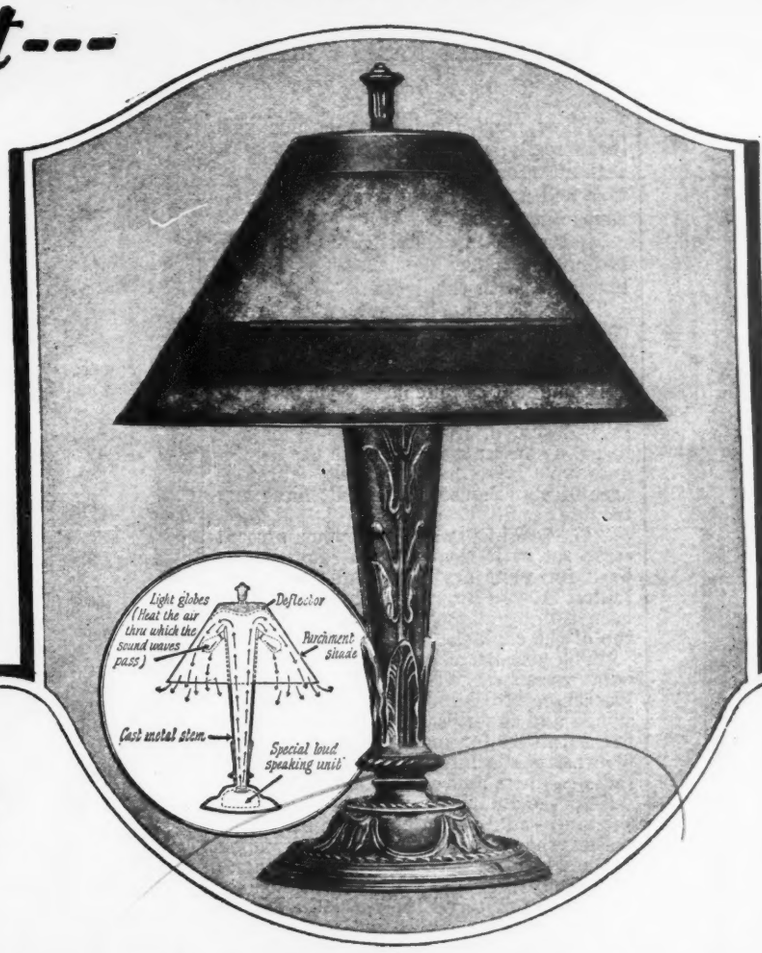
At Last---


Light globes (Heat the air thru which the sound waves pass)
Deflector
Parchment shade
Cast metal stem
Special loud speaking unit

Soft Mellow Light

You attach the light cord to any socket and switch on a soft glowing light. Then and there you will be convinced that you have the most beautiful library lamp money can buy.

Clear Resonant Radio Tone

Simply attach the Radialamp in place of the head phones. Then switch on your Radio set. Instantly the room is flooded with music so amazingly clear—so flawlessly resonant—you will wonder that any Radio loud speaker can give such perfect reproduction. **No. extra batteries—no adjustments.**

This Amazing New Twin-Feature RADIO LOUD-SPEAKER

THERE have been "horn type" loud speakers, box loud speakers, cabinet loud speakers—but never before in the history of Radio has there been such a sensation as the RADIALAMP. It is a loud speaker. It is a library lamp. Also it is an indescribably better loud speaker, from the perfected unit in the base, to the taut parchment shade that gives it the flawless, human tone resonance. And it is an incomparably more beautiful lamp, from the artistic cast metal stem to the light-mellowing shade made of specially selected parchment.

DEALERS

You Can Cash In On This Radio Sensation

Put this beautiful lamp and radio horn on your counter and sell it for the price of either a good lamp or loud speaker—both for the price of one. Put it into the window. See the radio fans collect—watch them stream in to ask questions, see them admire the beauty of the lamp—especially when it is lighted and they can appreciate the soft, mellow light as well as hear the perfect tone reproduction. Thousands are buying Radialamps in New York. It will make just as big a hit in your city. Write for further information.

Two Superior Features For the Price of Either

As a loud speaker alone compare the RADIALAMP with any of the old-type horns. Examine it carefully—see the latest scientific principles that make it a superior Radio horn. From the loud speaking unit concealed in the base the tone is amplified through the tapered tone chamber to the "sound mirror" in the top of the shade. Here it is deflected into the parchment shade through the warm air which is kept at a uniform heat by the light globes. The sound waves are intensified by the warm air which greatly increases the purity of the tone.

Even if you already have an old-type loud speaker you will also want the RADIALAMP for its beautiful music and its excellent reading light. You can put it in another room—if you wish to. Easily connected by a long wire to your receiving set.

Step in to your dealer to-day—see the RADIALAMP for yourself—you will be won over instantly by its astonishing beauty—it will positively add to the grace and charm of the already lovely furnished home. As an art piece—you will see that it is in a class by itself, and the price—the RADIALAMP is a superior lamp and loud speaker for the usual price of either one. If your dealer hasn't it, just fill in and mail the coupon. It will bring you complete information.

Radiolamp Company

Dept. 210, 334 Fifth Ave., New York

ON SALE AT LEADING RADIO STORES EVERYWHERE

RADIALAMP

TRADE MARK

LOUD SPEAKER

Radiolamp Co., Dept. 210
334 Fifth Ave., New York.

Please send me at once complete information about RADIALAMP loud speaker.

Name .....

Address .....

City ..... State .....

To Bore Holes -No.81

IT'S new. We've built this drill difference into it. Hard wood tests drills. Smooth and clean No.81 makes its twisting cut into hard wood—no sticking.

Simplicity—another of No. 81's virtues. It's easy to get out the right drill point. Just loosen the knurled magazine nut—the handle slides down the frame, exposing the points. Each drill point has its own pocket—number and size marked plainly.

The handle fits the hand comfortably. The whole tool is polished and nickeled with a bright finish which will endure.

If you don't own an automatic drill you need No. 81. If you do—you'll quickly see the difference in No. 81. Another good Millers Falls tool. At your dealer's.

MILLERS FALLS COMPANY
Millers Falls, Mass.
28 Warren St. New York 9 So. Clinton St. Chicago

MILLERS FALLS TOOLS
SINCE 1868

Specifications

Eight drill points
Improved ball chuck
Improved shell; cannot be completely unscrewed and lost
Handle handsomely knurled
Spiral nut of Tobin bronze
Highly polished and nickeled overall
Length 10½". Weight, each, 9 oz.
Packed one in a box.

Easily Built Radio Cabinet

(*Continued from page 85*)

"Show me," I said, "something that looks really well and yet can be made without mortises and tenons and dovetails and dowels and a whole lot of time-consuming cabinetwork!"

He took up my challenge without hesitation and a few days later sent me a blueprint, with this letter:

"Inclosed is a blueprint of the radio cabinet I was speaking about on the train the other day. With the exception of the crude 'soapbox' furniture that was written about so much a few years ago, it is about the easiest piece to make that has been designed. Any one able to make a box can construct it, and with the experience you have had in doing odd jobs around your house, you won't have any trouble at all.

"The cabinet will hold your present radio set as it is and leave room in the back for your dry cells and your table talker. If you buy the big horn you have been talking about, you can place it on top of the cabinet.

"The details of construction, I might add, were worked out by George F. Kaercher, of Philadelphia, who has designed and supervised the construction of fine furniture for many years and whose firm has made hundreds of thousands of radio cabinets and wooden horns.

"All the joints are plain butt joints—the kind you'd use in making a box. The reason the cabinet looks so well when finished is because the upper part is made of five-ply mahogany or walnut veneer. This is the material the furniture manufacturers use so much and every home woodworker certainly should take full advantage of it.

"IN THE first place, you buy it in large sheets, usually 30 or 36 in. wide and 60, 72, or 84 in. long. These sheets can be had with either one or both faces covered with choice veneer, often with fine figures—the sort of wood you see in expensive furniture and the paneling in shop windows on Fifth Avenue.

"The surface is smooth and perfect—it has been scraped and sanded to a finish that the amateur woodworker can rarely equal, even with the most painstaking work. Nothing whatever needs to be done to it except to cut it up and use it; and, of course, you can use as large pieces as you please without the work entailed in gluing together and cleaning up solid boards. Besides, this five-ply veneer holds its shape well; it doesn't crack or check or twist as so much solid woodwork does, especially as put together by amateurs. Finally, the veneer takes a splendid finish. You can make a professional-looking job with it, and do it easily.

"You will see that the cabinet is ornamented with overlays of thin veneer. Such ornamentation is now popular on commercial furniture of high quality, and, luckily, it is about the easiest decoration the amateur can apply—far easier than carving, inlaying, or even painting on decorations. And there is a great advantage in the use of overlays—they will cover the unsightly joints. Notice how the overlay around the edges of the ends covers and hides the plain butt joints.

"Making these overlays is really the same as the fretsaw work taught so generally in the lower grades of grammar schools. Get some thin veneer and glue it with the best quality of liquid glue or good hot glue to tough brown wrapping paper. Let it dry under pressure. You do not

(*Continued on page 116*)

KLEIN PLIERS

Next time you get a chance, ask the fellow who is a "crank" about fine tools, to let you look at his assortment of Klein's.

Pick up a pair; feel the easy way they balance; note the shape and spring of the handles, that make them easy to work with for hours without cramping; try the keen knives—get the hang of a fine plier in your own hands!

Any hardware distributor has them—just ask for Klein's!

Klein's "Pocket Tool Guide" is full of useful tables for the electrician. Drop us a card for one. It's free for the asking.

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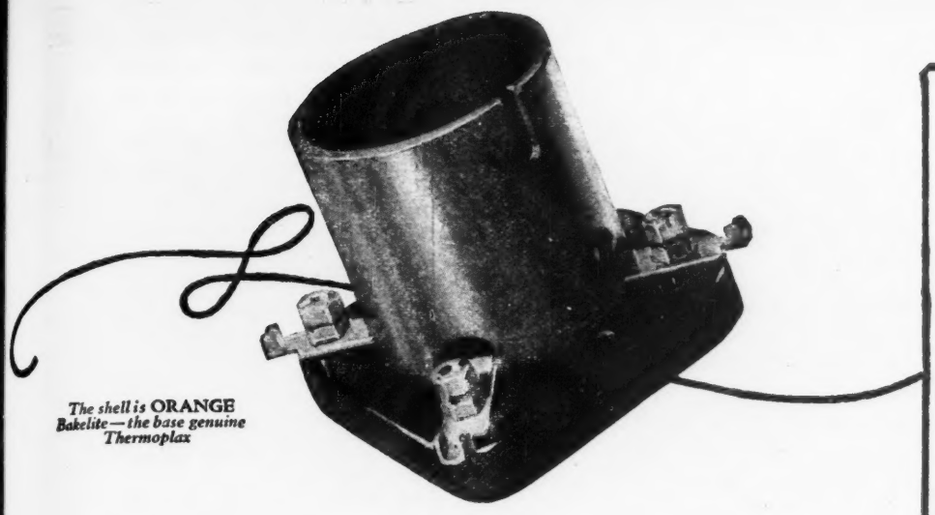
CHICAGO, ILL.

Mathias KLEIN & Sons
Established 1857 Chicago Ill USA



The shell is **ORANGE** *Bakelite—the base genuine Thermoplax*

At Last—A Radio Socket Worthy of This Famous Trade Mark

After months of experiment and research the Cutler-Hammer engineers announce this masterpiece of radio socket design. With features never before found in any socket, it brings to your set a degree of efficiency that means added miles of range and hours of clearer, more enjoyable reception.

Capacity has been absolutely minimized—without sacrifice of mechanical strength, and its base of ebony black Thermoplax in beautiful color contrast with the thin shell of orange Bakelite adds as much to the appearance of any set as this socket's construction does to its efficiency.

You'll like all of its many exclusive features—the silvered bronze contacts that afford *permanently* perfect contact; the slotted binding nuts; the handy terminals for soldering; the wide spacing of current carrying parts.

You'll like its appearance—neatness—small size. You'll like the way the tube is inserted and removed without twisting. And best of all, you'll like the price, 90c. *This socket that meets the specifications of the most exacting radio engineer costs no more than most of those on the market today.* Until all dealers have been stocked, you can be supplied direct from the factory at the retail price plus 10 cents for packing and postage. Be sure you have the genuine—it will pay you in every way to refuse all substitutes.

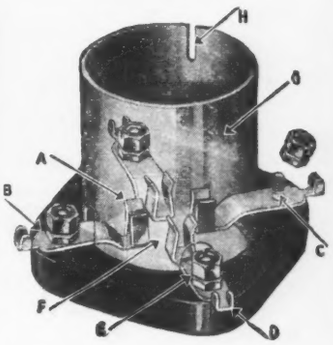
THE CUTLER-HAMMER MFG. CO.

Member Radio Section, Associated Manufacturers of Electrical Supplies

MILWAUKEE, WISCONSIN

C-H

These Exclusive Features Assure Better Reception



A

Perfect contact. Both sides of tube prong cleaned when inserted—no contact or wear on soldered end.

B

All metal parts *silver* plated—perfect contact for the life of the set. Silver may tarnish but its contact resistance does not change.

C

One piece contact construction. The binding post is NOT a part of the circuit—the wire to the socket always touches the contact strip which carries the current direct to the tube prong—no joints to cause losses.

D

Convenient terminals for soldering—full length to allow bending down for under-wiring. Ears hold wire in place for soldering.

E

Extra handy binding posts—tight connections with either wrench or screw-driver. Lock washers hold terminals rigid.

F

Wide spacing of current carrying parts both in air and insulation—true low-loss construction.

G

A minimum of both metal and insulation for low capacity. Shell of thin Bakelite—the base of genuine Thermoplax.

H

The tube is held in place by merely a vertical motion—no twisting to separate bulb from base.

The attractive orange shell helps identify this better socket, but the famous C-H *trade mark both on the socket and on the orange and blue box is your genuine protection*

C-H **RADIO SOCKET**

"Experience is the Vital Factor in Excellence"

The first "talking machine" became a finished reproducer of speech and music only by years of experience devoted to gradual development.

THOMPSON SPEAKER

Fourteen years devoted to making radio products furnished the background from which the Thompson organization has perfected the Thompson Speaker.

Each part of the Thompson is the result of the best known engineering experience and these parts are assembled in a manner that is possible only to experienced radio engineers.

The 7 superior and distinctively Thompson features are seven reasons why you should not "Just get along" with an ordinary speaker when you *can* get a Thompson. $28.

* * * * * * *

Few users ever need all the range and power that the Thompson Neutrodyne Radio Receiver will deliver. Made by the same organization. Now $125 without tubes or batteries.

R. E. THOMPSON MANUFACTURING CO.

Manufacturers of Radio Apparatus for the U. S. Army and Navy and numerous foreign governments

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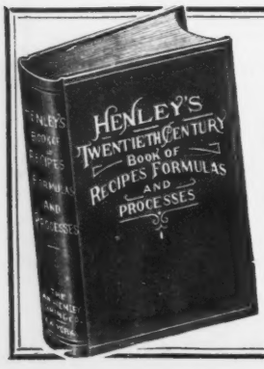

TWENTIETH CENTURY
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This book of 800 pages is the most complete Book of Recipes ever published. Hints, Helps, Practical Ideas and Secret Processes covering every branch of the useful arts are given.

A mine of information, up-to-date in every respect. Contains an immense number of formulas that every one ought to have that are not found in any other work.

Price, $4.00

Popular Science Monthly, 250 Fourth Ave., New York

Easily Built Radio Cabinet

(*Continued from page 114*)

have to glue it on paper, but I have found that it is desirable to do so in most cases because there is so much less danger of cracking the veneer or breaking off delicate corners in sawing.

"You can join several pieces of the veneer, one on top of the other, with touches of glue in what are to be 'waste' parts and, after marking the outline on the top, saw them out all at once. Use a fine fret- or coping-saw. A sharp knife also can be used for cutting the veneer, in which case it is well to moisten the veneer a little first. The miters and straight lines can best be cut by means of a knife and straight-edge.

"Then, to apply the overlays, you have two methods. One is to use cold liquid glue, not too thick, and spread it on the veneer or on the brown paper, if you have paper on the back of the veneer. Lay it aside with the glue exposed for about 10 minutes. Then put it in place and press it down well with a hammer or flatiron. The other method is to use hot glue, in which case the overlays are applied immediately and pressed, or 'laid,' as a shop man would say, with a hammer.

"The front edges of the box part of the cabinet may be covered with veneer put on like the ornamental overlays; this makes the best job. You can make square joints where the strips meet at each corner or miter the joints, as you prefer. Trim the veneer and round the edges a trifle with sandpaper after the glue is dry.

"IF YOU don't want to go to the trouble of veneering the edges, you can paint them with a brown enamel or with shellac colored opaquely to match the final finish; but to my mind that would be as much or more trouble than using the veneer.

"The stand is made of ⅞-in. stock throughout and the parts are glued and nailed together with finishing nails. You can use screws from inside to fasten the legs to the upper rails, if you wish, but the nails and glue will serve.

"In finishing, you can get easily the modern two-tone effect—the body of the stand and case being one tone and the overlays either lighter or darker. An easy way to accomplish this is to apply either walnut or mahogany oil stain—better use oil and run no risks of accidentally blistering the veneer or loosening the overlays—to either the overlays, if you want them darker than the rest, or to everything but the overlays. Then dilute the stain as directed on the label to lighten it considerably, and stain the whole piece. Fill the wood with either walnut or mahogany colored paste filler, or color some natural paste filler with a little of the stain you have used. Be sure to rub off the filler well, across the grain. Next, give a thin or wash coat or shellac to 'fix' the stain.

"After that, there are several methods of procedure. One of the best is to give several coats of shellac, and sandpaper each lightly with 00 paper, preferably a well-worn piece. Then finish with one or two coats of furniture wax, put on thin and polished long and briskly. Another method is to use one coat of shellac and two coats of varnish. The last coat of varnish should be rubbed with fine powdered pumice-stone and oil.

"Either of these finishes, if you use good material, will last and look well for half a century or more. Indeed, finished in this way, the fine cabinet woods improve with age and get more mellow and beautiful."

(*Continued on page 117*)

Easily Built Radio Cabinet

(*Continued from page 116*)

So there I was, well launched into my cabinetmaking venture. The first thing I did after studying the blueprint, was to go over the bill of materials, which was as follows:

2 pc. 5/8 by 18 in. by 2 ft. 4 in. five-ply veneer, mahogany or walnut faced on either one or two sides, for top and bottom of case.
2 pc. 5/8 by 17 5/8 by 16 3/4 in., same material, for ends.
2 pc. 1/8 by 13 3/8 by 16 3/4 in., same material, for doors.
1 pc. 3/8 by 16 3/4 in. by 2 ft. 4 in., three- or five-ply veneer, mahogany or walnut, for back.
2 pc. 3/4 by 2 in. by 2 ft. 3 1/2 in., mahogany or walnut (solid, not plywood), for front and back top rails.
2 pc. 3/4 by 1 3/4 by 15 1/2 in., same material, for top end rails.
4 pc. 3/8 by 2 1/4 in. by 2 ft. 4 in., same material, for facing of legs.
4 pc. 3/8 by 1 5/8 in. by 2 ft. 4 in., same material, for returns of legs.
4 pc. 3/8-in. quarter-round molding 2 ft. 2 1/4 in. long, mahogany or walnut, for filling pieces inside legs (optional; may be omitted).
2 pc. 3/8 by 1 3/4 by 13 3/4 in. mahogany or walnut, for bottom end stretchers.
1 pc. 3/8 by 1 3/4 by 20 1/2 in., same material, for bottom center stretcher.
1 pc. 2 ft. wide and 2 ft. 6 in. long, thin mahogany or walnut veneer, for overlays and to cover front edges of box.
2 pr. ornamental hinges, brass.
2 door knobs or pulls.
2 ball-and-socket catches, 1/4 in. in diameter, for doors.
Glue, nails, and screws.

I saw that there really wasn't much lumber needed—a sheet of 5/8-in. veneer 3 ft. wide and 6 ft. long and a small piece 3/8-in. veneer for the case, and a board for making the stand. My own lumber dealer had some mahogany on hand and I got a board 6 in. wide and 12 ft. long—more than enough to cut the stand. He didn't have any plywood, however, although he said he probably could get what I wanted in a week or two.

For the moment I was tempted not to bother with plywood, but to make the case from solid lumber, as it would be so easy to do, but I decided not to deviate from the original plan.

The next day I dropped into a lumber yard in New York and was taken up a ladder to a sort of loft, where I was shown immense stacks of plywood of all kinds.

We couldn't find any mahogany pieces 5/8 in. thick. There was plenty of 1/2 and 7/16 in. I was on the point of taking a piece of 1/2-in. mahogany veneer, beautifully marked in a sort of fiddle-back pattern, when I stopped and asked the price. It was 60 cents a foot for a 3 by 7 ft. piece, or $12.60. I thought that was pretty high, so did not take it.

My next effort to get the veneer was at a veneer factory in a town near my home, and there I got exactly what I wanted for 45 cents a square foot, and a piece of 3-ply stock, 3/8 in. thick, for the back, only one side mahogany, for 30 cents a square foot. These were cut up the exact sizes I wished, so that the making of the case was merely a matter of nailing the parts together. I took no chances on splitting the wood, but drilled holes first.

In laying out the parts for the stand, I found that by turning the legs end to end and laying them out one within the other, as it were, it was possible to economize material. I sawed the wood up just outside the lines, using my crosscut and rip saws for the straight lines and a narrow compass saw for the curves. Then, with a cabinet rasp, I completed the curves

(*Continued on page 119*)

We Amaze Men

With this Shaving Cream, whatever they expect

By V. K. CASSADY, *Chief Chemist*

GENTLEMEN:

Our claims for Palmolive Shaving Cream sound almost too good to be true. But they tempt millions to ask for samples.

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We do make good.

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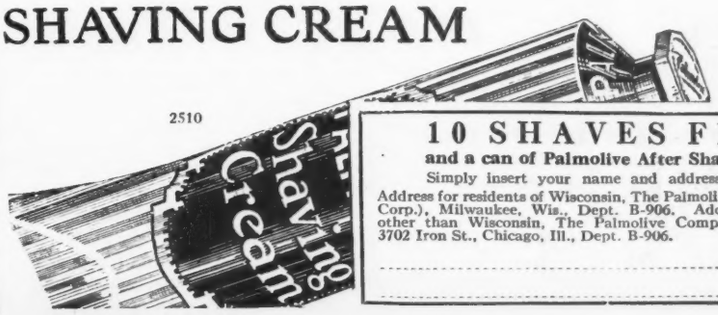

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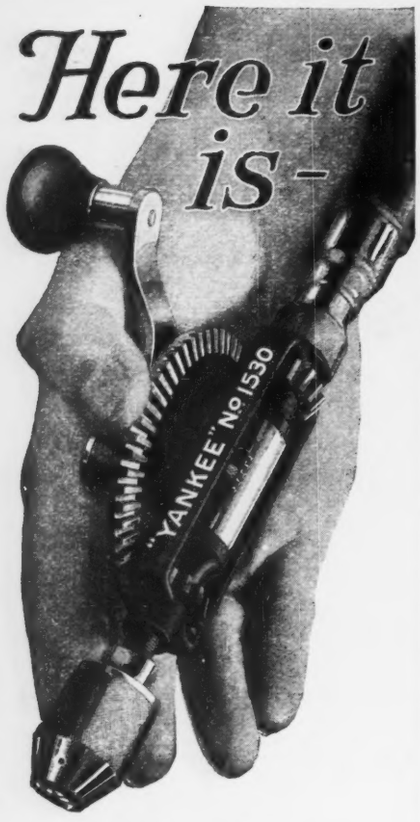

The Drill that works where others can't!

WHEN small holes must be drilled, in places too cramped for ordinary drills to operate, call on

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Although only 10½ inches long, and weighing only 1¼ lbs., this little "Yankee" Drill is built along the same lines as the big "Yankee" Ratchet Hand and Breast Drills. 3-jaw chuck holds up to 3/16 in.

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"YANKEE" TOOLS

Make Better Mechanics

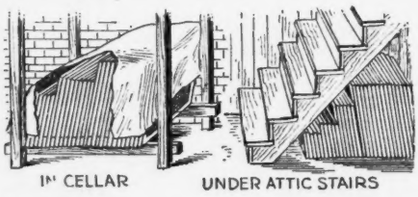
The Shipshape Home

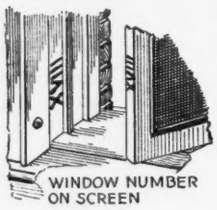
Caring for Fly Screens

THE importance of taking proper care of window screens can be illustrated by the experience of a friend of mine who owns 15 medium class one-family houses. To these homes every spring he sends a truck and gathers up from 75 to 100 screens, all requiring repair and many needing new wire. Yet in his own large residence practically no replacements have been made in the last 10 years.

The reason for this is that in his own case the man in charge of his grounds takes proper care of the screens, whereas, in the case of the tenants, with a few exceptions, the screens are taken down carelessly in the fall and thrown into any vacant corner of the cellar, uncovered and unprotected until they were needed in the spring.

When you take down the screens, gather all the loose screws, hooks, buttons, and attachments and tie them securely in a piece of canvas, fastening the bundle to the handle of one of the screen doors.





How to mark and store door and window screens

See that each screen is marked so that it can be replaced without waste of time next spring. The simplest and best method with which I am familiar is to mark all outside screens with Roman numerals cut with a ½-in. wide chisel. I prefer to mark on the left-hand edge of the window screen (looking through the window from the inside), about 2 ft. above the window-sill. The outside window-casing is marked in the corresponding position with the same number. It is surprising what an aid it is to number all the screens on the same side and about the same height from the sill.

If one doesn't care to mark the woodwork in this way, as, for instance, on certain styles of inside screens, metallic number tacks, which may be purchased cheaply at any hardware store, may be used, or the bottom of each screen may be marked with a heavy colored marking crayon, the designations being "B.R. Front" or "B.R. South," meaning bedroom front or bedroom south; "D.R. East," meaning the east window of the dining-room, and so on. If different colored crayons are used for different floors, the sorting out is facilitated. A good crayon mark on the bottom of an inside screen will remain visible for years.

When the screens are down, brush them well, doing the work outdoors and keeping your back to the wind so that the dust will be carried away from you. While doing this, note carefully whether any of the screens have a brown or slightly rusty look. These should be placed at one side for painting at the earliest opportunity; the wire may be past service if left until spring.

Asphaltum varnish, which is so useful both for preserving metal work and for use as a wood stain, may be used for painting the wire, or use regular black or green screen enamel. Boiled linseed oil to which a little lampblack has been added also is excellent, and this may be applied either with a brush or a small piece of close-grained sponge.

If any tears or holes are seen, they may be repaired readily, if not too large, with small screen wire patches, the edges of which are unraveled and caught in the screen.

Usually it is impossible to repair a "run" or tear along the line of tacks. In such a case, even if the wire is otherwise in good condition, it is best to put on new wire. The piece removed may be used for covering a smaller screen.

The screens should be packed together as closely as possible, on edge, and covered completely with cloth or strong paper. It is best to store them in the attic or a storage room. If they must go in the cellar, they should be put on a rack well off the floor.—A. E. ELLING.

Felt-Covered Rockers

THOSE who have hardwood floors in their houses know the difficulty in keeping them free from furniture scratches. Pushes and slides overcome the difficulty for furniture that has straight legs, but these will not prevent rockers from scratching the floor.

I have found the best thing to do with the bottom of a rocker is to glue on a strip cut from an old felt hat. Don't let the joint come where the rocker rests when idle. The felt lasts a long time and can be renewed easily when worn.—H. C.

Polishing Furniture

A GOOD furniture polish for general use is: One half pint of raw linseed oil, three tablespoons of turpentine, two tablespoons of grain or wood alcohol, three tablespoons of vinegar. Shake well before using. It may be used on the finest finish and will produce a rich gloss.—H. L. W.

Easily Built Radio Cabinet

(*Continued from page 117*)

where they were roughest and smoothed them with a spokeshave, scraper, and sandpaper. The other surfaces and edges were smoothed with a fore plane and a smoothing plane, although I could have done it all with the smoothing plane alone.

I glued and nailed together the legs first of all, then fastened the legs in pairs with the end rails and stretchers, and finally put the whole together.

WHEN it came to buying the thin veneer, I suppose I might have dropped into the shop of the old cabinet-maker in my own town, because he, no doubt, uses veneer in repairing antiques, but I looked up the New York telephone directory and found a firm that specialized in veneers and inlays. The workshop was on one floor of a loft building overlooking the East River—a rather rambling collection of workrooms, littered with an amazing profusion of veneers, bandings, inlays, and fretwork of many kinds. There I obtained a very fine sheet of thin mahogany veneer at the rate of 30 cents a square foot; plain, unfigured veneer was obtainable for 25 cents.

The veneers were prepared just as I had been told and cut out with a coping-saw. It was much less work than I had expected because I was able to cut four thicknesses at once. While sawing, I supported the work on a board with a V notch in the end; this was clamped so that the notched end projected from the bench top.

In gluing on the veneers I used liquid glue and was not a little astonished at how well the pieces stuck after the glue had set for five or 10 minutes.

Next, I put on the hardware, fitting the doors a little with a plane where necessary and placing a small block at the top and bottom to serve as a stop.

To apply the ball-and-socket catches I found it was necessary only to bore ¼-in. holes in the case and push in the catches, screwing the corresponding striking plates to the doors, where the ball-like projections would catch in them. I fastened the box part to the stand with four small brass angles.

AT ABOUT this stage, my wife was willing to admit that the cabinet looked like a piece of real furniture. Before this she had been more or less skeptical.

"Do you know," she said, "I think it could be made into a very nice desk. I saw one along the same lines—a box on legs—in a furniture store. Instead of the doors it had a single lid, hinged at the bottom; when open it was the writing table."

Another suggestion she made was that I build another stand exactly the same and put a plain top on it, with an inch or two overhang on each side.

"It would be just the right size for the little sewing-table I have been wanting to get," she explained.

The finishing was the most tedious and, if anything, the most difficult part of the whole work. I stained everything but the overlays a brown mahogany. Then I gave the entire cabinet a coat of thinner stain, puttied the nail holes with colored putty, and filled, shellacked, and waxed it.

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Is the determination to succeed, the overcoming of obstacles and constant ceaseless work.

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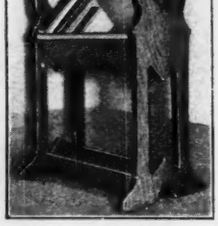
Radio Cabinet Is First of New Simplified Blueprints

A UNIQUE addition is made to the Home Workshop series of blueprints this month in No. 35, a simplified radio cabinet. This is a useful and attractive piece of furniture that can be made without difficulty by beginners in woodwork. It requires only a few of the more common hand tools, and the joinery necessary is of an elementary kind; plain butt joints are used throughout.



Book trough and end table, Blueprint No. 3

The blueprint is substantially the same as the illustration on page 85, but on a much larger scale. The details are full size, so that the outlines of the decorative overlays can be used directly as patterns. This saves considerable re-drawing and insures accurate conformity to the details as originally worked by George F. Kaercher. A complete bill of materials, or cutting list, is included on the blueprint.

Another simple project is the book

(Continued on page 121)

Complete List of Blueprints

ANY one of the blueprints listed below can be obtained from POPULAR SCIENCE MONTHLY for 25 cents. The Editor will be glad to provide, upon request, information relative to tools, material, or equipment.

Blueprint Service Dept.
Popular Science Monthly
250 Fourth Avenue, New York

GENTLEMEN:

Send me the blueprint, or blueprints, I have underlined below, for which I inclose.....cents:

No.	*Title*	*Price*
1.	Sewing Table	25c
2.	Smoking Cabinet	25c
3.	Book Trough End Table	25c
5.	Kitchen Cabinet	25c
6.	Two-Stage Radio Receiving Set	25c
8.	Shaving Cabinet	25c
9.	Arbor with Gate and Seats	25c
10.	Porch Swing	25c
11.	Bench and Tilt-Top Table	25c
12.	Electric Washing Machine	25c
13.	Tea Wagon	25c
14.	Toy Train, Horse, and House	25c
15.	Home Workshop Bench	25c
16.	Inlaid Radio Cabinet	25c
17.	Cedar and Mahogany Chest	25c
18.	Telephone Table and Stool	25c
19.	Grandfather's Clock	25c
20.	Flat Top Desk	25c
21.	Colonial Writing Desk	25c
22.	Girl's Cabinet and Desk	25c
23.	Pergola Garage	25c
24.	Gateleg Table	25c
25.	Sailing Outfit for Canoe	25c
26.	Baby's Crib and Play Pen	25c
27.	Kitchen Cabinet Work Table	25c
28.	Pullman Play Table	25c
29.	Toy Tea Cart, Garage, etc	25c
30.	Tool Cabinet, Bench Hook, etc	25c
31.	Priscilla Sewing Cabinets	25c
32.	Chinese Game Table	25c
33.	Pullman Dining Alcove	25c
34.	Trellises for House and Garden	25c
35.	Simplified Radio Cabinet	25c

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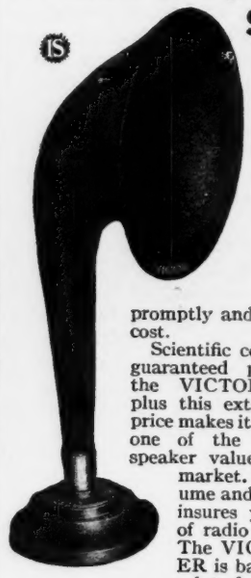

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Scientific construction and guaranteed performance of the VICTOR SPEAKER, plus this extraordinary low price makes it unquestionably one of the greatest loud speaker values on the radio market. Its unusual volume and clarity of tone insures you the height of radio enjoyment. The VICTOR SPEAKER is backed by an absolute factory guarantee

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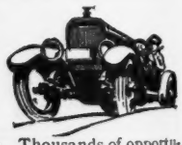

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Substitute for Vacuum Bottle Made for a Few Cents

THE picnicker and tourist can construct with little difficulty a homely but serviceable container for keeping liquids hot or cold.

Obtain a 1-gal. pail with tight-fitting lid and a heavy glass bottle short enough to fit into the pail with an inch to spare, and about 2 in. less in diameter than the pail. Such a bottle will hold from 1½ to 2 qts. A supply of heavy corrugated cardboard, a circle of plain cardboard, a cork and some hard sealing-wax — wax that scarcely is affected by very hot water —also are needed.

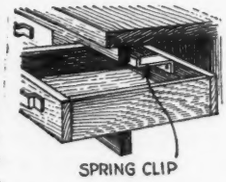
Corrugated paper serves as insulator

Cut from the corrugated board five disks just large enough to fit into the bottom of the pail. Wrap another strip until five turns have been made about the bottle itself, and then slip bottle and tightly wrapped covering into the pail. Cover this with a disk of plain cardboard in which a hole has been cut for the bottle neck. Then seal with about ½ in. of wax.

If suitable wax is hard to obtain, mold a cover of cork dust to fit over the top of the bottle. The dust is mixed with glue diluted one half and allowed to dry. When the can cover has been put on, the insulation is exceptionally complete for a homemade affair and this bottle can be handled quite roughly.—D. R. V. H.

Stop for Bench Drawer

OFTEN a bench drawer is pulled out too far and the contents are upset. This cannot happen if a simple bench drawer stop is provided, as illustrated. To install or remove the drawer, the clip is pressed down.—A. L.



Radio Cabinet Blueprint

(*Continued from page 120*)

trough and table illustrated, of which the builder, H. Caldwell, of Toronto, Ont., writes:

"The first article I have made with the aid of POPULAR SCIENCE MONTHLY'S blueprints is shown herewith, and I am very proud of it, as, for one not accustomed to it, it is very gratifying to observe the work of one's hands.

"This production is the end table, blueprint No. 3, and I made it of oak at a cost of $3.50 for the material. It was very simple to make and the blueprint easy to follow, but it was some contract to jig out the ends.

"I finished it by sandpapering well, fuming with ammonia and giving two coats of shellac, which I rubbed down with felt and pumice. This gave a fine satin finish, which makes this end table a 'classy' piece of furniture, and well worth my effort. I am so tickled that I am going to try my luck at one of the other articles on the list."

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QUARTER-INCH PORTABLE ELECTRIC DRILL
"With the Pistol Grip and Trigger Switch"

$28, In Canada $36.

Grinding Outfit.—Consists of stand which can be fastened to bench top, arbor with clamp washers and nut, and grinding wheel. $3—In Canada $4

Bench Drilling Stand. The drill can be inserted or detached quickly by means of handle clamp. $12, In Canada $16

Free to Owners of Black & Decker Quarter-Inch Drills

A grinding outfit (as illustrated above) for the Black & Decker Quarter-Inch Drill, price $3.00, will be given free to the first 100 owners of Black & Decker Quarter-Inch Drills, who will write and give us information on the following three points:

1. The serial number of your Black & Decker Drill, which is shown on the name plate.
2. The name of the store from which you purchased it.
3. Not less than 25 words and not more than 50 words, telling us for what work you find it most useful.

In order to receive one of the above stands free your letter must be written in ink or on a typewriter, on one side of a sheet of paper, with your name and address clearly shown, and must reach us at the address shown below not later than October 31, 1924.

We will not wait, however, to send you the grinding outfit, but will send one of these grinding outfits free to each of the first 100 who reply to this advertisement just as soon as their reply is received.

IS

Address Contest Department

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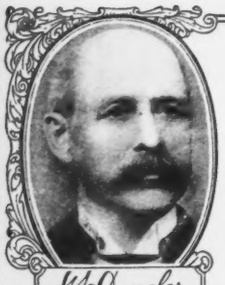

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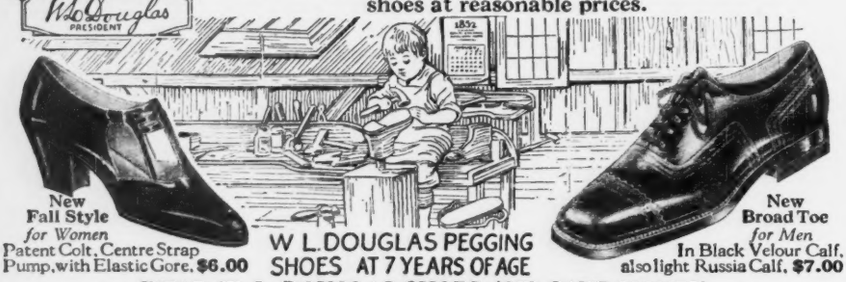

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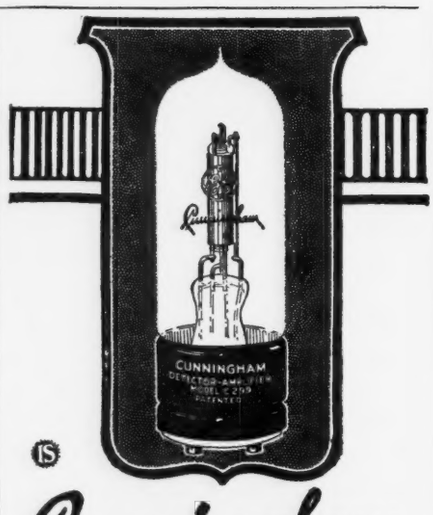

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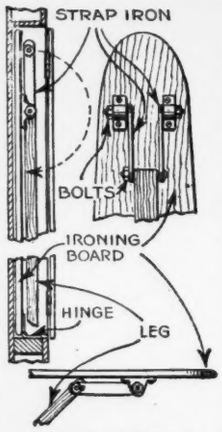
Wall Ironing-Board Folds into Small Cupboard

THE difficulty of building an ironing-board to fit into the wall lies in the construction of the leg. Some types have a hinged leg that extends straight down when in use. Others have a leg that is long enough to be placed at a slant, but this has had to be detachable to permit folding it into the wall.



The leg is hinged with two iron links

The illustrations show the method I devised to allow the use of a long leg placed at an angle. The advantage is that garments may be slipped over the end of the ironing-board, yet the board and leg fold together into the closet.

The leg extends from one end of the board down to the intersection of the floor and wall. It it fastened to the board by means of two strap irons, as indicated. A long hook in the inner wall of the closet keeps the ironing-board from dropping out unexpectedly when the door is opened.—J. G. BYBERG, Silverton, Ore.

Cabinet Type Bench

(*Continued from page 87*)

piece mortised at right angles into the lowered end of the outer jaw passes through a slot in the baseboard of the bench. This piece slides in and out, as necessary, and is held in position by a pin that is placed in any one of the several holes, according to the width the jaws are to be opened.

To preserve the new wood, rub it with raw linseed oil and when dry follow with a coat of shellac.

You will find such a bench will become more valuable to you every day. Your tools are free from dust and close at hand. Expense has been kept to a minimum, and the parts of the washstand not used can be saved to develop other ideas in the home workshop.

Carpenters usually prefer to place a vise of the type described by Mr. Tribute at an angle, so that the outside jaw, or at least, the right-hand edge of the jaw, slants downward from right to left. The lower guide piece then has to be farther toward the left. Such an arrangement gives considerably more "grip" to the jaws where it is most needed, that is, to the right of the vise screw. This is important because one's work frequently is so large that only the right-hand side of the vise can be used.

Photographic Vignetting Masks Made of Cut Film

By Edward H. Flaharty

WITH the use of cut film, vignetting masks may be made to produce the effect of diffused edges or fade-outs on photographic prints (Fig. 1), as though an air-brush were used on the negative before making the print. This new method does away with air-brush work or the slow and uncertain method of exposing through a mask a few inches from the printing frame.

Fig. 1. Portrait made with mask

A piece of process cut film (process film is of extreme contrast) is placed in a printing frame with the emulsion side out. Over the printing frame (and a few inches away from it) is placed a cardboard box or other mask in which a hole has been cut, either round or oval, and about one-third smaller than the diffused area desired. A short exposure is made by a dim electric light a few inches from the frame. The distance will determine the amount of diffusion.

When the film is developed, it will be found that a large diffused black area appears in the center (Fig. 2). When this piece of film has been dried, it is placed in a printing frame. Behind it another piece of film is placed and a second exposure made. The center of the second film is transparent and the outside black (Fig. 3).

In making prints from the portrait negative, this second piece of film is placed in front of the picture film and the paper. The result will be that the portion of paper in back of the opaque edge of the mask is not exposed and the resulting print shows the edges of the picture fading out into the white space around it.

Fig. 2. The first or preliminary film

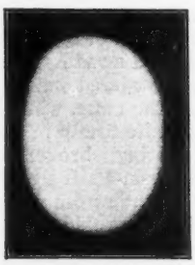


Fig. 3. The second or masking film

A set of these celluloid masks may be made of many different sizes and shapes and used to meet various needs.

These masks may be used in grouping several prints on one piece of paper, as is often done in arranging different poses of children on one strip of paper for framing.

Similar masks to those described above could be made by the same method for bust portraits where it is desired to have only the bottom half of the picture fade out into white or black.

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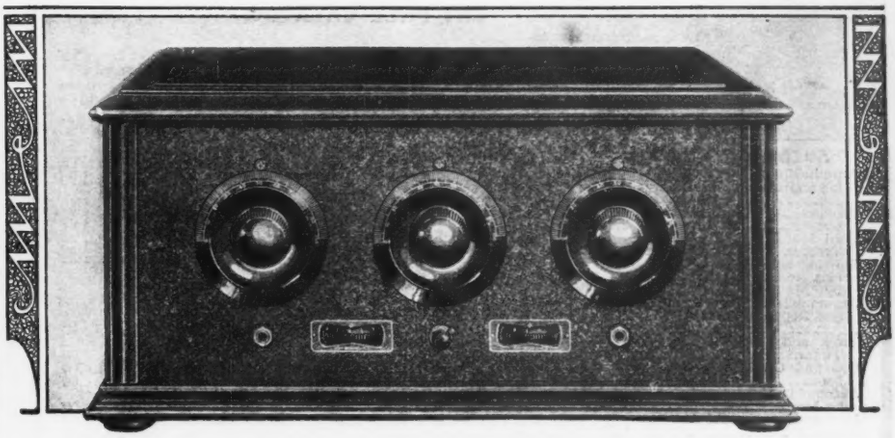
ELECTRICAL EQUIPMENT



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Circuit: Two stages of tuned radio frequency amplification, detector and two stages of audio frequency amplification.

Tubes: Five in all. Jacks provided for either five or four tube operation.

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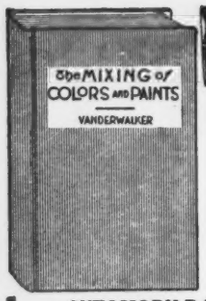

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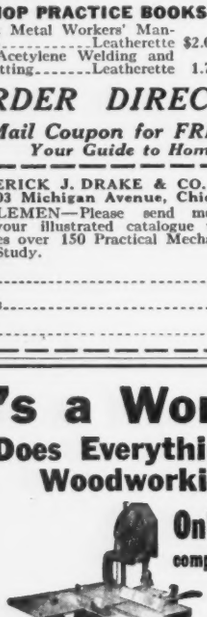

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Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

HOW putty can be made has been mentioned before, but the removal of hardened putty from cracks and crevices is another story. At times it is exceptionally difficult, or almost impossible.

To loosen putty under such conditions, dissolve lye (sodium hydroxide) in a little water in a glass vessel and add, for each two tablespoons of lye, one teaspoon of hard soap cut in shavings. Dissolve the mixture with slight heat. When cold it should have a gelatinous consistency; if this is not the case, add a little more soap. Apply this mixture to the putty quite thickly and leave for a day or two, and the putty will be softened so that it can be removed easily.

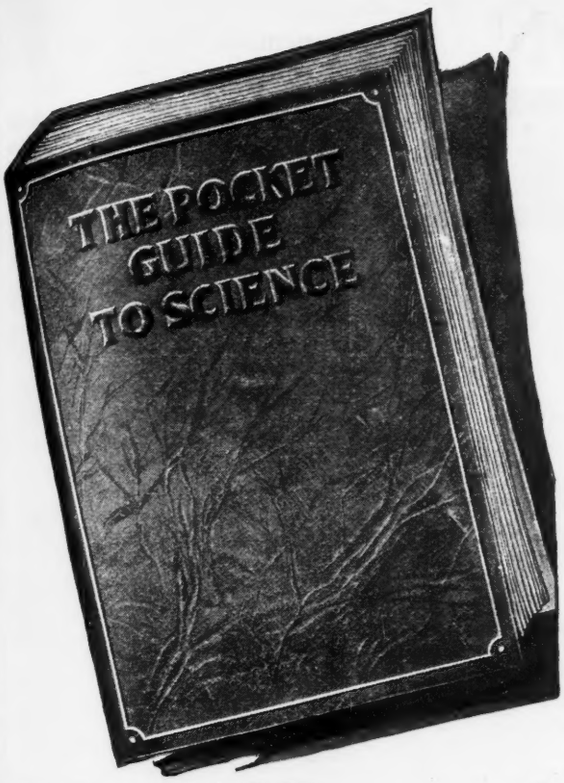
Knives that have loosened from their handles can be reset firmly. In a porcelain or iron dish melt two teaspoons of rosin and add, while stirring, one teaspoon of precipitated chalk. Pour the molten mass into the handle. If the handle is thin and narrow, merely mix the two substances intimately together after they have been powdered, and force as much as possible of this powder into the handle. Then take the knife and, wrapping the blade in a wet cloth to keep it cool, heat the haft over an alcohol or bunsen flame. When it has attained a red heat, insert the handle into the powdered mass. The hot shank will melt the mass, which when cold will hold the knife firmly in the handle.

Using a plaster-of-Paris cement to repair a broken ornament (above) and resetting knife in handle (at the right)

Uniting broken pieces of marble, plaster-of-Paris figures, alabaster and objects made from composition ivory is not difficult provided the broken pieces are not too heavy and are not subjected to much wear. To make a cement for this purpose, take four tablespoons of plaster of Paris and mix with one tablespoon of powdered gum arabic. When it is to be used, add a little cold water until a thick paste results on mixing. Apply this paste within five minutes of preparing, as it sets and hardens quite rapidly. This is valuable for reuniting objects of sentimental value, which are not used every day.

Repairing broken glass, porcelain, and

(*Continued on page 126*)



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Why does an iron ship float?
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What are electrons?
Is electricity a form of matter?
What is a crystal?
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Why do the stars twinkle?
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P. S. 10-24

A LESSON ON CHIROPRACTIC

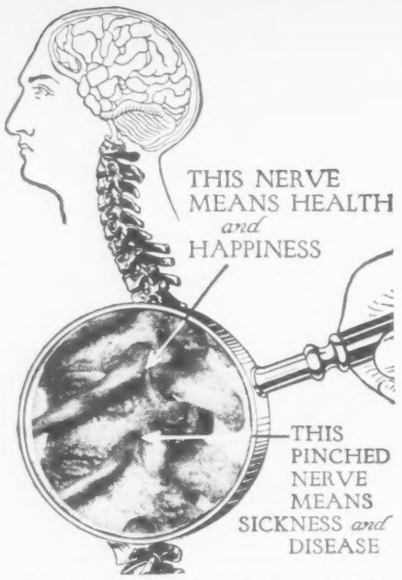
WHEN you wish your arm, hand, leg or any other part of the body to do something, a message is sent to that member over the nerves.

If the nerve over which the message travels is pinched, the message cannot get to the member to which it was directed; the member does not obey the mind, and it then is what we call diseased.

Chiropractic teaches that all the work that is done in the living body is done by an intelligent power within by means of functional impulses sent over the nerves, and that disease is the result of an interference with the normal transmission of these functional impulses over the nerves.

Chiropractic teaches that your arm or leg will obey the mind if the channel over which the moving or motor impulse is open and normal, but that if a segment of the spine becomes slightly misaligned and presses on the nerve, thereby stopping the motor impulse, the result is what is called paralysis.

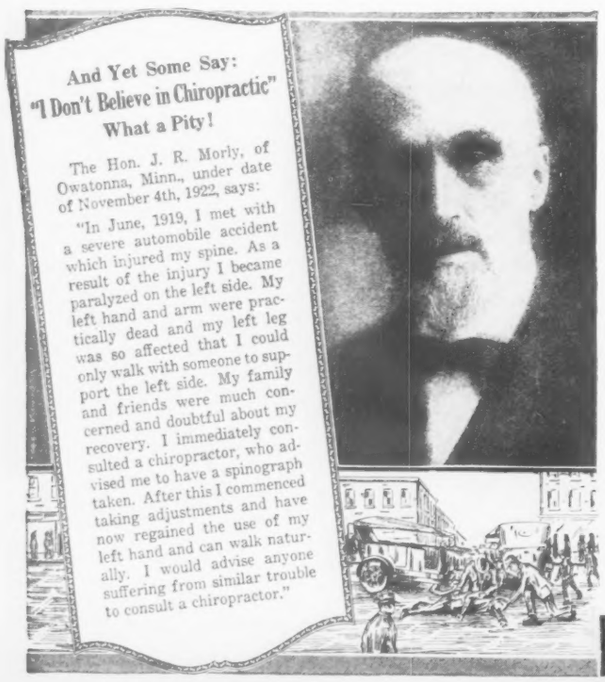
The accompanying cut shows how the nerves, over which all functional impulses are sent, come out through the spinal windows between the vertebrae, and how a misaligned vertebra may press upon or impinge



the nerves, thus interfering with the flow of functional impulses, which causes dis-ease.

To adjust the vertebra to normal, thereby removing the cause of disease, is the work of the chiropractor.

Thousands have realized that paralysis is simply a lack of motor impulse to the affected part, when complete recovery followed the release of the prisoned functional impulse through the adjustment of the misaligned vertebra by a competent chiropractor.


And Yet Some Say:
"I Don't Believe in Chiropractic"
What a Pity!
The Hon. J. R. Morly, of Owatonna, Minn., under date of November 4th, 1922, says:
"In June, 1919, I met with a severe automobile accident which injured my spine. As a result of the injury I became paralyzed on the left side. My left hand and arm were practically dead and my left leg was so affected that I could only walk with someone to support the left side. My family and friends were much concerned and doubtful about my recovery. I immediately consulted a chiropractor, who advised me to have a spinograph taken. After this I commenced taking adjustments and have now regained the use of my left hand and can walk naturally. I would advise anyone suffering from similar trouble to consult a chiropractor."

Write for information regarding Chiropractors or Schools to the

UNIVERSAL CHIROPRACTORS' ASSOCIATION
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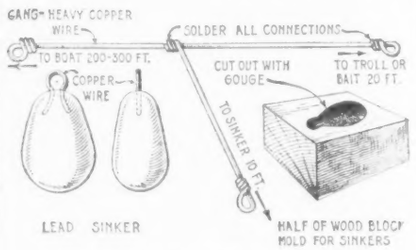
Homemade Tackle Aids in Trolling for Lake Fish

IN MY fall fishing trips on deep lakes for pike and lake trout, I have found extremely effective the tackle described below, especially in getting the big fellows out of their hiding places.

It is necessary to troll near the bottom with two or three hundred feet of line out. A gang is made of heavy copper wire as illustrated, roughly in the form of a Y. All the connections and loops are well soldered to stand the strain when a "whale" attaches itself to the troll.

A sinker is made of lead about the size of an egg. It may be poured in a wooden mold cut in a block of wood, or, better, in



Details of the wire gang and the sinker, which is cast in a wooden mold

two blocks of wood. An eyelet of heavy copper wire is inserted in the mold before the melted lead is poured. Bend the ends of the wire outward before inserting, so as to insure a good hold for the eyelet.

About 10 ft. of line is used to connect the sinker with one branch of the gang. The troll is connected with 15 or 20 ft. of line to the other branch, while the main line to the boat is fastened to the remaining portion. This gang allows the lead to sink the troll, but keeps it 10 ft. away from the bottom and consequently lessens the likelihood of entanglement at all times.

When the lead is felt touching bottom, take in a few feet of line or speed up the boat a little and the troll will be kept spinning along in just the right place.—STANLEY W. BLANCHARD, Grand Mere, Quebec, Can.

Home Workshop Chemistry

(*Continued from page 124*)

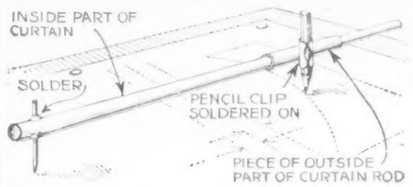
the like can be done with various cements. It is possible to mend the fracture so skilfully that the joint hardly can be noticed, but seldom, if ever, will the repaired article be safe to use. If mended with alum, isinglass, gelatine, or any other substance that is either soluble or softened by water, the repaired article will loosen at the point of union and break at the slightest pressure, especially if placed in hot water.

White lead thinned with boiled linseed oil to a very heavy paste so that it can hardly be spread with a knife will mend china and porcelain, but its disadvantage is the long time required for it to dry, three or four months being necessary. White of egg mixed with a small quantity of plaster of Paris is also good, but it requires careful handling, even after uniting the break. But above all, remember that water is injurious to this cement.

Serviceable Bar Compass Made from Brass Curtain Rod

A BAR compass or a pair of trammels frequently required in laying out circular work in the home workshop can be made easily and cheaply from an old brass curtain rod and a metal pencil clip, as shown below.

A hole the size of a tenpenny wire finishing nail is drilled in the end of the inner



Drawing an arc of long radius with simple homemade bar compass or trammel

rod. The nail is ground to a sharp point and fastened in the hole with a drop of solder. A 3-in. length of the other rod is used as the sliding part of the compass. To it the pencil clip is soldered.—F. S. ROOT, Fall River, Mass.

How to Build and Cover an Upholstered Footstool

(*Continued from page 86*)

and driving in only a few large tacks. This is called "slip-tacking" and is shown in Fig. 6. Draw the muslin over the top of the stuffing and slip-tack the other side. Repeat the process at the ends.

A stuffing regulator, which is a piece of wire shaped as shown, is used as in Fig. 5 to scratch the stuffing under the muslin, should it appear uneven. Care and patience should be used in drawing this muslin tight to form a smooth top.

A piece of sheet wadding usually is placed over the muslin. This is cut to fit the legs, but is not tacked.

The final covering is put on in much the same manner as described for the muslin (Fig. 6). Genuine leather, imitation leather, tapestry, and cretonne, all make excellent covers. It is well to choose some material that will match other pieces of furniture in the room.

Much care should be taken in cutting around the legs. Always cut out a small square in each corner first and gradually fit to the legs as the covering is stretched on. Stretch the final covering very tightly and slip-tack as in Fig. 6. Use 4-oz. tacks for finishing and keep them close to the edges so that they will be hidden by the gimp.

You may buy gimp to match your covering or you may make it from 1-in.-wide strips of the same material as your cover and turn both edges under so that they will be held in place when the upholsterer's tacks or nails are driven.

If Design No. 2 has been chosen, no gimp is necessary, but especial care must be taken to turn the covering under so that a smooth finished edge will fit closely against the legs and along the edge, where it is nailed as shown in Fig. 9.

Small metal glides driven into the bottom of each leg add much to the serviceableness of the stools and prevent the marring of polished floors.

MODEL K $29.50

Encased in beautifully finished *solid* mahogany with genuine polished black Bakelite front panel. A two tube tuned radio frequency outfit, of finest construction, quality throughout. An amazing value in long distance sets. Fully guaranteed. Now everyone can enjoy a quality radio set! Mail coupon below. List $29.50.

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NOTE: Because the Miraco embodies improvements, refinements and features used in expensive sets, it is able to perform as these users tell you it does. Send coupon for names of nearby users, further testimonials and descriptions.

New York Hears London and California!

Have reached as far as 2LO, London, England and KGO, Oakland, Cal. The Miraco is the best set I have ever used.—C. A. Henry, Vernbank Village, N. Y.

Michigan Hears Cuba!

The first station I picked up was Cuba. The Miraco is surely wonderful—the finest I have ever heard. Am certainly satisfied with mine. Will see that you get other orders soon.—Ernest Serviz, Holt, Mich.

Texas Hears Porto Rico!

I have 125 stations on my log to date. The following are the pride of my Miraco: San Francisco, Los Angeles, Springfield, Mass, San Juan, Porto Rico, came in through much static.—Clifford Gilland, Franklin, Texas.

Illinois Hears N. Y. and California!

Our Miraco Model K is great and I believe is the best on the market. Have heard stations all over the U. S. Also Cuba. We hear New York and California most every night.—Mrs. F. K. Prophet, Pawnee, Ill.

Ohio Hears Oregon!

Miraco working fine. Just heard Atlanta, N. Y. City, Davenport, Ia., Tampa, Fla., Fort Worth, Dallas and Portland, Ore. I guess that is range enough, isn't it?—T. R. Mann, Ashland, Ohio.

Oklahoma Hears a-Plenty!

Am going to talk Miraco to everyone I see. Have received more stations with it than I have ever received with any other set costing fifty or sixty dollars more. —F. J. Brink, Grove, Okla.

Minnesota Hears Texas!

Using a Miraco "K," I get reception from coast to coast and from Calgary, Canada, to Houston and Dallas, Texas.—R. E. Runquist, Cokato, Minn.

West Virginia Hears California!

I have succeeded, with my Miraco, in tuning in over 50 stations, including WFAA, WBAP, WGAM and best of all—KGO, Oakland, Cal. —E. H. Davis, Williamstown, W. Va.

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Pin to letterhead or write name and address on margin below.

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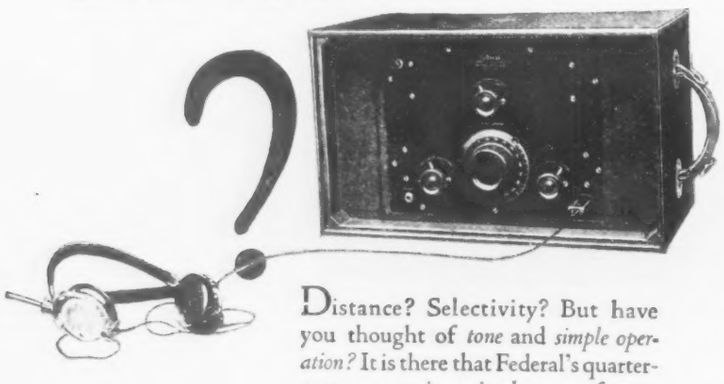

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Sunlight Used in Stenciling Designs on Woodwork

By Ernest Bade, Ph.D.

WOODWORK made in the home workshop, such as trays, picture frames, book ends, smoking cabinets, and the like, can be ornamented with designs stenciled by means of sunlight.

The process is simplicity itself, but requires considerable time. All that is done is to cover the panel or piece to be decorated with either one of the commercial stencils that can be obtained in great variety at any paint store, or a homemade stencil, and expose it to the sun for two or three weeks. This results in a rich brown design, varying in depth according to the time of exposure. It is much clearer and sharper on the edges than the ordinary stencil made with stain or paint.

Stencil ready for exposure

The soft woods, that is, the pines, give the best results. The stencil, which may be stencil board, cardboard, tin or wood, is attached to the freshly planed surface of the wood in such a way that it will not shift or curl. If it is of thin cardboard, cover the stencil with plate glass.

When the desired shade or darkness has been obtained, the design is fixed by polishing or by coating the surface with varnish or wax. It is best first to oil the surface with a mixture of boiled linseed oil and turpentine. Use just a little and rub it into the wood. When dry, repeat the operation. The oil is used primarily to bring out the grain of the wood. Follow the second coat with one or more coats of furniture and wax, thoroughly polish with a clean rag.

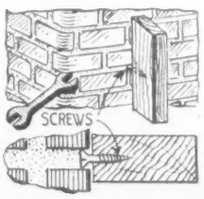
Design as printed by sun (at right)

Waxing the design (at left)

Mending an Umbrella

BROKEN joints between the braces and ribs of an umbrella can be repaired with friction tape. Simply put the end of the brace where it belongs and wind tightly with the tape in such a way that the action of the joint will not be interfered with unduly. The umbrella then can be opened and closed without difficulty and the repair will be found to last surprisingly well.—W. S.

Simple Tools Form Raked and Rodded Brick Joints

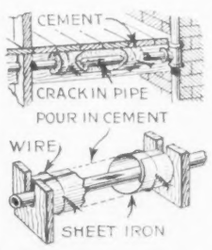


A MORTAR remover for recessing brick joints can be made from a 1 by 6 in. block of wood with a large wood screw turned into one edge. The head of the screw is left exposed the depth that the mortar groove is to be.

When the mortar has set awhile, the tool is run along the joints, cleaning out the mortar neatly. A set of ordinary S wrenches provides excellent burnishers for the grooves. Different sizes will fit joints of different widths.—FRED W. PAGE, Winfield, Kan.

Cement Repairs Split Water-Pipe in Emergency

HOW Portland cement was used to repair a cracked water-pipe is shown in the accompanying illustration. The pipe, which was split by freezing for about 4 in., was located in a rather awkward place, so that the cement trick saved much time and expense.



How cement saved an awkward water-pipe replacement

The water was shut off the line and a piece of sheet iron bent around the pipe to make a retainer about 2 in. larger in diameter than the pipe. The cylinder was tied with wire and the ends were stopped with two pieces of thin board. An opening was left at the top to pour in the cement, which was allowed to set for several hours before the water was turned on.

The cement sealed the break and stood the pressure as well as the original pipe. This will suggest other possible repairs to valves, tanks, wooden tubs, vats, cisterns, well pumps, and the like.—H. W.

Homemade Fire Pails Have Handles Riveted on Bottom

FIRE pails filled with sand or water should be kept at convenient places around every shop or farm building. Sand should be used in pails that are hung near electrical machinery.

Fire pails may be made at home by fastening a heavy sheet-metal handle to the bottom of an ordinary pail, as illustrated. This gives an excellent grip when the contents are to be thrown on a fire and is as effective as the rounded bottom in preventing the use of the pails for other purposes than fire prevention.

The handle may be riveted on for use with sand and soldered for use with water.

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Use it on those dark cellar stairs. Use it in that dark attic. Flood that dark closet with the brilliance of high noon. Keep several Evereadys about the house. And keep them handy!

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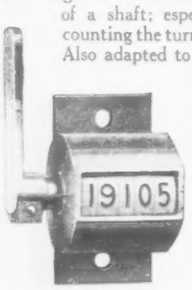
When you're winding a coil for your radio, a Veeder Counter comes mighty handy for counting the turns of your winder.

When you're trying to step-up the production-rate of a newly developed *machine*, a "*VEEDER*" counts output or operations so each gain *registers*—for your guidance.

When you want to run a machine, a generator or other apparatus at a certain *speed*, you get a count of the *R. P. M.* most conveniently from a

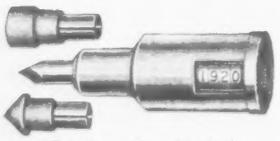
Veeder COUNTER

The small Revolution Counter below registers one for a revolution of a shaft; especially handy for counting the turns of a coil winder. Also adapted to recording output (or operations) of many types of light machinery. Mechanism will stand a very high rate of speed. If run backward the counter subtracts. Price $2.00. (*Cut 4-5 size.*) Small Rotary Ratchet Counter, to register reciprocating movements of small machines, also $2.00.



Speed Counter

Here's the handiest instrument for finding revolutions-per-minute of a shaft or flywheel. You hold the tip of the counter against end of revolving shaft; press lightly when the second hand of your watch comes to 0; release pressure when minute is up. A spring clutch controls the recording mechanism.



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The Veeder Speed Counter enables you to keep motors, engines, generators, line shafting and machines operating at **efficient speeds.** Price, with two rubber tips, (as illustrated) $3.50.

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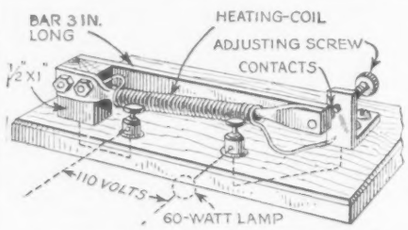
44 Sargeant St. Hartford, Conn.

Heating Coil Operates This Simple Electric-Light Flasher

AN ELECTRIC-LIGHT flasher that operates automatically on the principle of a thermostat is made as shown in the accompanying illustration. This type of flasher is in extensive use, to control a single lamp behind a transparent sign.

The heating core is 250 turns of No. 38 insulated German silver wire. If this is not available, No. 38 s.s.c. copper wire will serve the purpose for experiments, but it heats excessively with constant use.



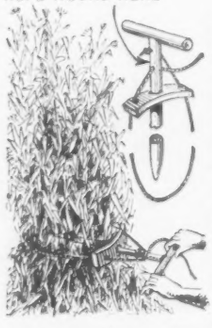
Alternately heating and cooling, the coil moves the contact arm back and forth

The flasher arm is insulated with thin asbestos paper before the coil is wound on.

When a current is turned on, the heating coil, being in series with the lamp, receives current and its resistance prevents the lamp from lighting above a dull red. The heat from the coil causes the brass bar upon which it is wound to expand, and it pushes the other bar, being cold, over until contact is made with the adjusting screw point. This short circuits the heating coil and causes the lamp to light up to full brilliance. The heating coil then cools and this causes the bar to return to its original position, when the whole series is repeated.—THOMAS E. MILLER.

Weatherproof Corn Shocks Made with Simple Tying Tool

THE tool illustrated for tying corn shocks has proved most efficient. By turning the handle like an auger, the rope is wound around the pin and the shock compressed evenly in all directions. This insures a weatherproof shock.



Twisting the handle draws shock together

The curved shield is made of a 1½-ft. section of a wide wagon rim. A central hole is drilled through it to take a free working pin and two other holes are drilled to take a small rope. The pin, which is 2½ ft. long, also has two holes of the rope size.

In use, the sharpened end of the pin is shoved into the corn shock and the rope, one end of which is fastened to the pin and passed through one of the holes in the shield, is carried or thrown around the shock and slipped through the other hole in the shield and the remaining hole in the pin. It is pulled tight and the handle is twisted to compress the shock.—HARRY FRYE, Tullahoma, Tenn.

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National Stationery Co., 1787 Lincoln Highway, Batavia, Illinois

Graceful Music-Stand Made from Left-Over Pieces of Wood

THE ordinary metal folding music-stand used by violin and saxophone players and other instrumentalists always looks out of place in a well furnished living-room. Wooden stands of the commercial type are usually so cumbersome and heavy as to be equally out of place. When a more appropriate music-rack is desired, it is a simple matter for the amateur woodworker to make a light and graceful stand that will look well alongside any piano.

The original of the stand illustrated was made of the finest mahogany, but any good cabinet wood will serve. It is used for sheet music only; for heavy music books the pedestal should be stouter, but the same method of construction and general proportions should be followed.

A light stand for sheet music

Left-over pieces were used for the material, the parts required being as follows:

2 pc. for standard ⅞ by ⅜ by 12 in.
1 pc. for standard 1⅛ by 1⅛ by 17 in.
4 pc. for feet ⅞ by 2½ by 14 in.
2 pc. for base frame ⅜ by 1 by 17 in.
3 pc. for music-rack 7/16 by ¾ by 17 in.
2 pc. for music-rack 7/16 by ¾ by 9 in.
1 shaped pc. for rack ⅞ by 1⅜ by 9 in.
2 square pc. for stand ¼ by 1 by 1 in.
Round-headed screws.

Make the stand of three pieces, using doweled joints. Glue only one end of each dowel, so that the stand can be taken apart. Then place the pieces together and plane them up straight and square, making the standards 1 in. square at the bottom and ⅝ in. at the top. Insert the small blocks at the joints and complete gluing the joints together.

The feet may be cut out of pieces of the size given above, or, with less waste, out of one wide piece. Nickel-plated, brass, or other round-headed or oval screws are used to fasten the feet to frame.

The bottom frame has a half-lap joint at the center and is glued together. It is then screwed to the feet with fine screws, or doweled and glued.

The rack itself is made as shown in the detail. The bottom piece is made the shape indicated and screwed to the rack. The shaped block at the back also is screwed on the rack at top and bottom and is bored at the correct angle to receive the standard.—A. E.

Thong Holds Watch Securely

WHENEVER I put on rough clothes for camping, I use a leather thong for my watch as a safeguard against loss and breakage. Belt lacing about ¼ in. wide and 10 in. long with slits cut as shown is entirely satisfactory.—L. W. H.

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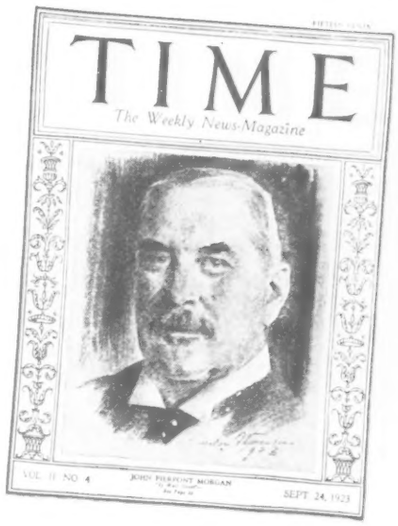
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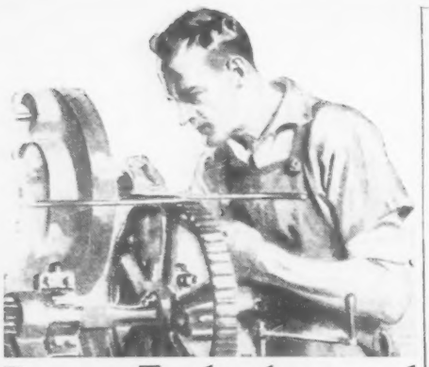

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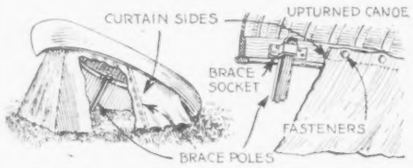
Special Curtains Convert Canoe into Comfortable Shelter

By Leroy W. Hutchins

WHEN a canoe cruiser needs a waterproof shelter for stormy weather, he is fortunate if he has provided props and special curtains so that he can turn his canoe upside down and convert it into a small tent.

To fit up a canoe in this way, fasten metal loops to the inner sides of the gunwales, one on each side of the canoe, about one-third from the end. These hold the two prop poles, which may be any light wood about 5 ft. or more in length, and carried along, or new poles may be cut for the purpose at each camp.

To fit the curtains, prop up the canoe and tack one edge of the cloth to the gunwale on one side; pull the cloth to the floor as desired, and tack it lightly. When the shape of the side is satisfactory, cut the cloth just beyond the line of tack to allow for a hem. When one side is made, it can be used as a pattern for the other.



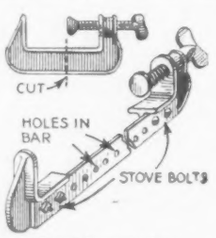
The canoe shelter set up and method of fastening brace poles and side curtains

Provide snaps or obtain patented fasteners to attach the curtains to the canoe, and either insert metal grommets or tape loops along the lower edges for staking down the canvas. Provide tapes at the forward end for tying them.

Such a shelter is quite roomy, being 6 or 7 ft. wide, 5 or more ft. high at the center and usually about 16 ft. long.

Ordinary C-Clamp Lengthened for Cabinetmaking

AN ADJUSTABLE furniture clamp may be constructed cheaply from an ordinary iron C-clamp and a length of stiff band iron. Saw the clamp in two and drill two holes about 1 in. apart through the back of each half. Rivet or bolt the bar to the half that carries the thumb-screw.



Band iron used to lengthen clamp

Drill one hole about 1 in. from the other end of the band iron. Fasten a stove bolt through this hole and through the hole nearest the end of the other half of the clamp. Using the other hole as a guide, drill the band iron; then move the clamp along one hole and repeat the operation. In this way a series of correctly spaced holes will be made, giving a wide range of adjustment between the ends of the clamp.

The uses to which the furniture clamp is put will determine the length of the band iron.—RICHARD C. TARR.

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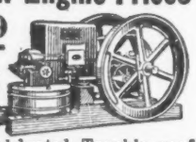

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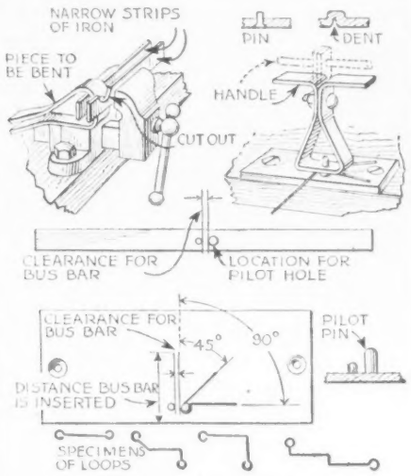
Homemade Loop-Former Insures Neat Radio Connections

ONE of the greatest aids to radio fans is a loop former for bending neat and uniform loops in the bus bar commonly used for connections. Various types of commercial benders are available, but I have found that the homemade one illustrated serves excellently.

To make one like it, take any flat strip of iron you have on hand, say 1/16 in. thick, $\frac{3}{8}$ in. wide, and about $5\frac{1}{2}$ in. long, and drill a hole in the center. In this rivet a small pin, or else make a large dent or impression. In either case, the projection need be only a trifle higher than the bus bar or wire that is to be used. Next, drill as shown, a hole for the pilot, which should be about 5/32



How the former is made and used to bend loops and angles in bus bar

in. in diameter for loops to fit No. 6/32 machine screws.

To bend the loop-former, clamp it as indicated in a vise, after first placing it between two other narrow strips of iron, one of which should have a clearance hole or cutout. To shape the grip or handle, bend out the ends at right angles and fasten with a rivet or bolt, or leave straight and pass a rod through the ends.

The base plate is approximately 1/16 in. thick, $1\frac{3}{4}$ in. wide, and 3 in. long. Near the edge and at the center, rivet a pilot to fit the pilot hole in the loop-former. Alongside, rivet a guide pin or make a dent as in the case of the loop-former. Scribe marks on the base plate to facilitate bending offsets at various angles. Also indicate by an arrow how far the bus bar must be inserted between the pin and pilot to form a perfect loop. This can be ascertained by trial.

Insert the bus bar between the pin and pilot on the base plate, press down firmly with the loop-former and turn to right. Give it another slight, quick turn before releasing it and you will have formed a perfect loop.—P. A. DASCHKE.

SOLDERING paste may be carried and applied most conveniently when in a tube such as is used for tooth paste or shaving cream. An old tube can be used for this purpose if it is unfolded and the end cut off. After it has been filled with soldering paste, crimp the end tightly.

An Amazing Advance in RADIO Design

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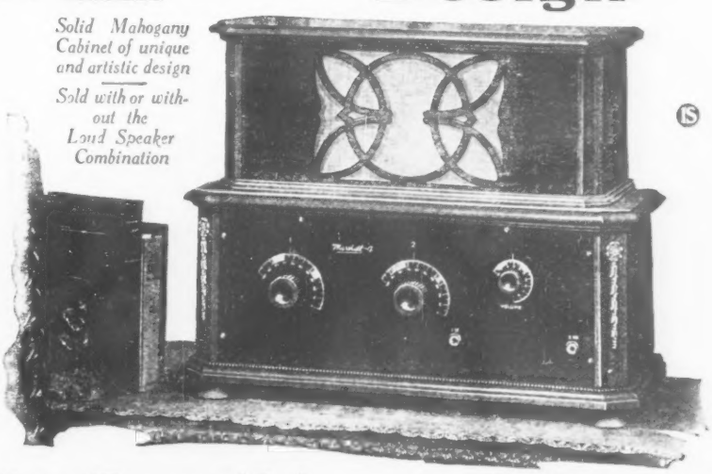

Solid Mahogany Cabinet of unique and artistic design

Sold with or without the Loud Speaker Combination

This Beautiful Marshall 4 Tube Non-Oscillating Receiver only $5.00 DOWN

Complete with all accessories

WRITE TODAY for full particulars of this most exceptional offer. Marshall Sets embody the very latest improvements known to radio. They are licensed under Pfanstiehl Patents Pending, and utilize the wonderfully efficient Pfanstiehl Non-Oscillating System. This discovery of Carl Pfanstiehl is the big sensation of the 1924-25 radio season. The set that has achieved zero coupling, the big thing that every designer has been striving for. A set with zero coupling cannot oscillate. It is positively non-regenerative. It brings to radio a new degree of musical quality. Its selectivity will delight the experienced radio operator. Yet it is so easy to tune that the novice will handle it like an expert.

Easy Monthly Payments—2 Weeks Free Trial

That is the remarkable offer we are prepared to make to you! Two weeks to prove that the outfit you select is everything we have said for it. If it doesn't make good our claims, back it comes, and your deposit will be cheerfully refunded. But if it fulfills all your expectations, you may pay for it in easy monthly installments. You don't risk a cent when ordering from us. You *must* be satisfied, or we don't do the business.

Is it any wonder that the radio buyers the country over are rushing to take advantage of such an offer? If YOU are interested, figure on getting your order in early, while prompt shipment can be made. Everyone predicts a serious shortage of radio supplies this season. Send for full particulars today.

Beautiful Solid Mahogany Cabinets

Just compare the beautiful outfit pictured above with the usual radio box and horn! The speaker cabinet appears as part of the combination unit. Designed by a master designer—fashioned of the finest solid mahogany, it will harmonize with the furnishings of the finest homes. Yet through our different way of merchandising, this exceptional cabinet value—plus the unequalled mechanical qualities of the Marshall set—plus easy terms—you get them all for actually less money than ordinary sets sell for on a cash basis.

Complete Outfits if Desired

In buying from Marshall, you have the choice of a set complete with all accessories, or the set alone. You have choice of dry cell or storage battery outfits. Unless you already own the accessories, you can buy them from us at less-than-market prices, with your set on easy terms. Your outfit will come all ready to set up and operate within a few minutes,—saving time and trouble—and saving money, too.

Send Coupon for Special Offer

If you have any idea of buying a radio set this year, don't let this chance slip by. Our terms and liberal guarantees have set a new pace in the radio business. The low prices we will make you on a 3, 4 or 5 tube Marshall set will surprise you. A letter, postcard, or just the coupon will do. But send it today!

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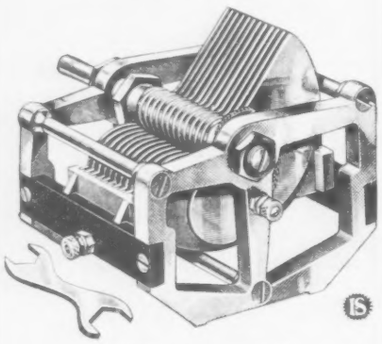

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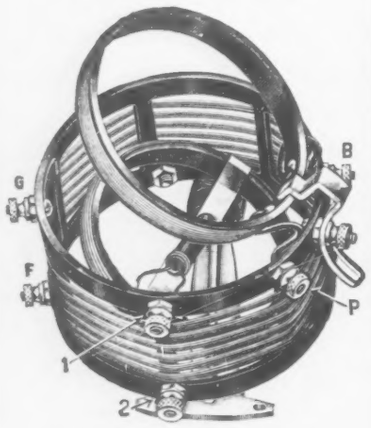

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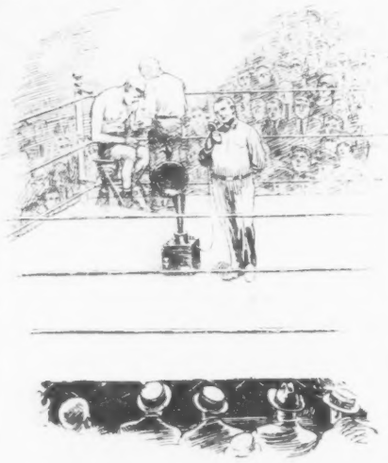
Simple Vacuum-Tube Amplifier Replaces Megaphone

By B. Francis Dashiell, M. E.

THIS loudspeaking or signaling device is designed especially for use where it is necessary to transmit the voice across space, such as from ship to shore, or from ship to ship, and for announcements during athletic contests. It is valuable in some cases on the farm. The device also might be used in directing airship landings.

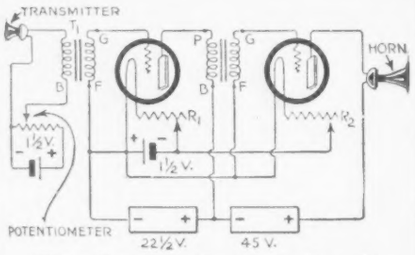
With the use of this set it is possible for the speaker to talk into the transmitter of the apparatus in an ordinary tone and have his voice amplified to such an extent as to carry perfectly many times farther



Announcer using portable loudspeaking outfit to introduce boxers in a large stadium

than is possible with a megaphone. The use of a megaphone, or like device, causes the speaker to strain his voice and the listener often is unable to understand easily what is being said.

The entire apparatus is contained in a small box, which is portable and may be fitted with jacks for plugging in the transmitter and the loudspeaking horn. On shipboard, the box may be placed where convenient. The transmitter is on the bridge, and a horn on either side of the vessel is connected by means of a switching arrangement at the transmitter so that a horn on the side of the vessel next to the pier may be used.



Wiring diagram showing how familiar radio hook-up is used in this amplifying device

The apparatus consists of a series of amplifying radio tubes and audio-frequency amplifying transformers connected somewhat similarly with the usual audio-amplification stage of a radio receiving set. Too many tubes can not be used unless great care is exercised in the selection and wiring of the parts. However,

(*Continued on page 135*)

Newly Discovered Paste Shines All Shoes

Recently a chemist invented a remarkable paste which shines any shoes. This amazing new kind of paste is cream white in color and comes in a convenient tube. It is only necessary to apply a little and rub with a soft rag. Immediately a lustrous finish appears on black, tan, brown or patent leather shoes. This paste is known as CEROLA. It softens and preserves the leather and will not stain the hands or clothing. CEROLA is now demanded by particular people everywhere. Men and women are making amazing incomes introducing this and other Harley specialties to their friends and neighbors.

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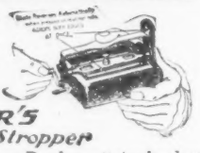

$1.50 KANNER'S Dubeledge Stropper

Models: For Gillette: Durham Duplex; all single edge blades. Order now—pay when you receive stropper.

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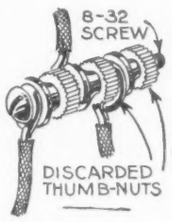
Old Binding Nuts Useful for Emergency Radio Connections

IN ALMOST every handy-man's or radio fan's "catch-all" box may be found thumb-nuts from discarded dry cells and also 8-32 machine screws of various lengths. These, when used as illustrated, are a great help in radio and other electrical experimenting, especially when a hurried connection or extension of wire must be made for testing purposes. This little kink saved me from embarrassment one evening and I am confident others will welcome the suggestion.—H. WENZ.



Several binding posts used on one screw

Testing a Radio Receiving Set for Battery Connections

THERE is an easy way to find out whether a radio B battery is connected with the filament or A-battery circuit without the necessity of using a voltmeter.

Before making the battery connections, connect one terminal of the A battery with the positive A-battery terminal of the set and try the other terminal of the A battery on the various positive B-battery terminals.

Next, connect the positive of the A battery with the negative A-battery terminal of the set and try the negative of the A battery on the various positive B-battery terminals of the set. Have the tubes in and the rheostats turned on. Then, if the tubes do not light up, it is safe to connect the B batteries into the circuit. If the tubes light, it will pay you to check up on the connections.

Amplifier Replaces Megaphone

(*Continued from page 134*)

two or three tubes and transformers will give a powerful amplification that will carry long distances, provided suitable loud-speaking horns are used.

An ordinary telephone transmitter is used. It should be connected with the primary of an audio-frequency transformer using one dry battery cell, with a potentiometer to regulate the current flowing through the transmitter.

The secondary of the transformer is connected with the grid of the first tube, of either the 1½-volt or 6-volt type, according to the voltage that is to be used on the set. If made portable, the 1½-volt tube must be used and the battery carried in the box. Otherwise, a 6-volt storage battery is needed.

The plate of the first tube is connected with a 22½-volt B battery through the primary of the second transformer, the secondary of which goes to the grid of the second tube. The plate of this tube is connected with the loudspeaking horn and thence to the 45-volt B-battery terminal.

If it is desired to add additional tubes and transformers, the same arrangement is followed as in the case of the second tube and transformer, except that the primary of the third transformer is substituted for the horn.

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Genuine Underwood

Rebuilt in our own factory just like new for

ONLY $3 down—NOT ONE CENT MORE

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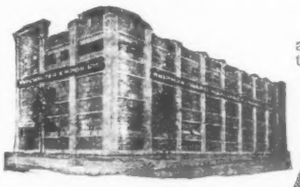

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An up-to-date machine with two-color ribbon, back spacer, stencil device, automatic ribbon reverse, tabulator, etc. In addition we furnish FREE waterproof cover and special Touch Typewriter Instruction Book.

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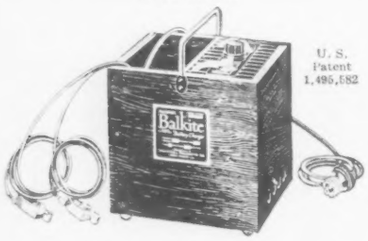

A noiseless bulbless radio battery charger

Entering the field late last year, the Balkite Battery Charger is today universally accepted as one of the most efficient and trouble-free methods of charging radio batteries.

1. This charger is entirely noiseless. 2. It cannot deteriorate through use or disuse. 3. It has no moving parts or bulbs. 4. It has nothing to adjust, break or get out of order. 5. It cannot discharge or short-circuit the battery. 6. It requires no attention other than an occasional filling with distilled water. 7. It delivers a taper charge, and cannot damage the battery by overcharging. 8. It cannot fail to operate when connected to the battery and line current. 9. It is unaffected by temperature or fluctuations in line current. 10. It is simple, efficient and indestructible except through abuse. 11. Without added attachments the charger may also be used to charge "B" storage batteries. 12. *It can be used while the set is in operation without disturbing sounds.*

The Fansteel Balkite Battery Charger will charge the ordinary 6 volt radio or automobile storage battery at 3 amperes, from 110-120 AC, 50-60 cycle current.

Manufactured by
Fansteel Products Company, *Inc.*
North Chicago, Illinois

Price $19.50

West of Rockies $20
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At your dealer's. If your dealer cannot supply you, sent prepaid on receipt of price

FANSTEEL
Balkite
Battery Charger

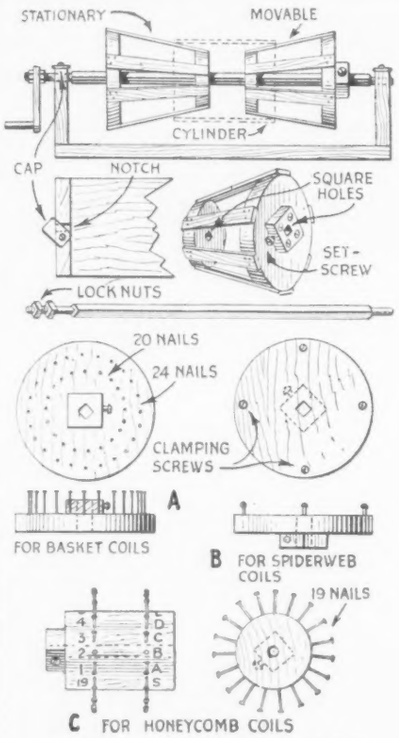
Winder for Making Radio Coils

By L. B. Robbins

A WINDER is a necessity for the radio experimenter who makes many coils. The one illustrated at the top of the accompanying illustration can be made easily by the amateur and will save many hours of arduous labor. It is designed primarily to wind plain, cylindrical coils, but three attachments can be made by which basket, spider, and honeycomb coils may be wound.

The base is a board about 6 by 18 in. with a 5-in. upright at each end. A deep groove in the top of each upright acts as a bearing for the shaft. Caps over each bearing hold the shaft in while operating, but can be swung aside to allow the shaft to be taken out when desired.

The shaft is of ½-in.-square iron or steel rounded at each end. One end should



The winder with cones for holding tube forms and fixtures for special coils

be threaded and furnished with two locknuts for a crank.

Two wooden cones, as illustrated, serve as the coil-mounting holders. They are made of wooden disks connected by thin slats. The large end is 4½-in. in diameter and the small end 2½ in. in diameter. One should be fixed permanently to the shaft; the other has a hub block with a setscrew to allow adjustments.

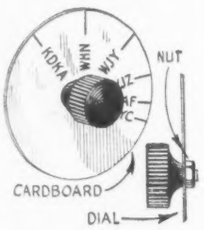
A cylinder is placed in position by removing this cone, lifting the shaft, slipping the cylinder in place, and then replacing the shaft and pushing the two cones together.

Attachment *A* is for winding basket coils. It is a disk 5 in. in diameter, with 24 nails evenly spaced in a 4-in. circle and 20 nails in a 3-in. circle. The larger winds the stator coil and the smaller the rotor. The nails must be removed after winding. This fixture is placed on the shaft in place of a cone and is held by a setscrew.

Attachment *B* is a similar disk with four screws near the rim for fastening down the spider form. The setscrew block should be on the opposite side.

For winding honeycomb coils use a wooden cylinder, *C*, 4 in. long and 2 in. in diameter. Drive two rows of 19 nails each around the circumference, parallel with each other and ⅞ in. apart. A hole then should be drilled through the exact center and a retaining screw and block fastened to one end.

Setting Radio Dials Quickly

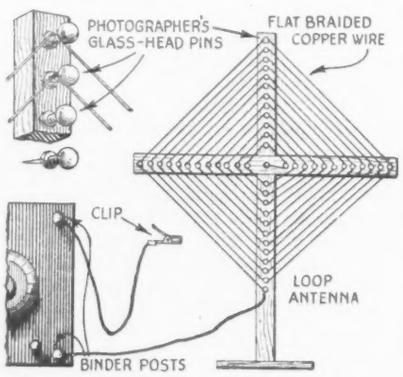


MY MOTHER, who is quite old, enjoys listening to radio programs, but does not care to tune in stations by the usual hit-or-miss fashion. To allow her to turn instantly to the station she wished, I cut a cardboard disk and fastened it with a nut to the knob section of a two-part dial. The old dial was discarded and the new cardboard one marked to show where each station could be tuned in.—R. A. KELLY.

Adjustable Loop Aerial for Use with Super-Heterodyne

A LOOP aerial that is adjustable in length to suit receiving conditions and therefore is especially suitable for sets of the super-heterodyne type, may be made easily by the method illustrated.

A frame of conventional design is made of ½ by 1 in. white pine, with a round or square base. The arms are studded with glass-head pins, such as photographers



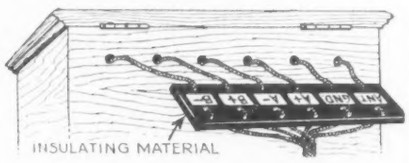
By adjusting the clip, any number of turns may be included in the loop circuit

use. On these pins is wound a length of bare, braided copper wire.

One end of the winding is fastened to the pin in the center, and the other to a binding post on the radio panel. Connect a short piece of flexible wire with the other binding post and solder a clip on the loose end, so that it may be snapped on the loop at any place. This allows the closest possible tuning of the aerial circuit.—GEORGE A. MOHL, Buffalo, N. Y.

Safety Strip Prevents Mix-Up of Radio Connections

THERE is hardly a radio fan who at some time or other has not burnt out one or more tubes by connecting the battery wires incorrectly. Even though a tube is not blown out, a wrong connection often gives a great deal of difficulty. A friend of mine tore down his set entirely before he discovered that the trouble he



The incoming wires are threaded through a marked strip of thin insulating material

had been having was due only to a mix-up in the incoming wires.

To aid in overcoming these difficulties, provide a safety connecting strip made as shown from any odd, thin, narrow piece of fiber, hard rubber, or other insulating composition. If there are six incoming wires, as is generally the case, pierce the strip with six rows of three holes each. Lace wires through them, as shown, and mark each wire distinctly.—PAUL A. DASCHKE, New York.

Imitating Fumed Oak

FUMED oak is one of the most effective and popular finishes for plain or quarter-sawed oak furniture, but an air-tight box large enough for fuming is rarely available, especially in the home workshop.

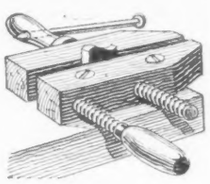
A similar finish can be obtained quite easily by making a stain of ordinary asphaltum varnish well diluted with turpentine. This is applied with a brush and wiped off with old cloths. A filler is not used, but, when the stain is well dried, give the wood a coat of orange shellac and finish with furniture wax well rubbed in.

A dark wax is more effective than the natural color. This may be made by melting any standard wax in a double boiler and stirring in some ivory black mixed with a small amount of turpentine to break up the lumps. Great care should be taken because of the violently inflammable materials used. Keep a cover for the melting dish handy and if the wax should catch fire accidentally, clamp on the cover. The wax is used cold.

The same method of finishing is effective on interior woodwork.—S. W. B.

Carpenter's Handscrew Serves as Bench Vise for Small Work

A CARPENTER'S handscrew made of hard maple, as it usually is, forms a practical bench vise for small work on brass or wood. The handscrew is fastened near the edge of the bench with two wood screws, and a large nail, spike, or rod may be used, if desired, to turn the handle on the far side.—J. D. G.



Will She Say "Yes" — the Second Time?

WHEN the last strains of the music have faded away—when the dance is over—you thank your partner and she smiles back at you. But is her smile forced—did she really enjoy the dance? Will she say "yes" when you ask her for the second dance?

Does any girl want to dance with a clumsy, awkward leader? Does she want to stumble along with a partner who is constantly falling out of step?

Why Good Dancers Are Popular

If you long to be popular, admired, envied—actually sought after—learn to be a *good* dancer. You can do it—right in your own home—with neither music nor partner. All you need is Arthur Murray's wonderful, new, home-lessons in dancing. And no matter how little you know about it now—with these remarkable, simplified Print-and-Picture instructions, you can master any of the newest and most popular steps in a few hours. Why, you'll be amazed to see how quickly you will be able to waltz, fox-trot, one-step, lead or follow with perfect ease and confidence.

Many of the foremost society leaders of America and Europe have chosen Arthur Murray as their dancing instructor. He is recognized as the most prominent dancing authority in this country.

Five Dancing Lessons FREE

Over 200,000 men and women have already learned to dance through Arthur Murray's astonishing methods—and so sure is he of their startling, quick results that he is willing, for a limited time only, to send *Five Lessons Free* to everyone who returns the coupon. Enclose 25c (stamps or coin) to pay the cost of postage, printing, etc., and the five lessons will be promptly mailed to you. There's no obligation whatever. So act now. Arthur Murray, Studio 275, 290 Broadway, New York City.

Arthur Murray, Studio 275
290 Broadway, New York

To prove that I can learn to dance at home in one evening you may send me the FIVE FREE LESSONS, which are (1) The Secret of Leading; (2) How to Follow Successfully; (3) How to Gain Confidence; (4) A Fascinating Fox Trot Step; (5) A Lesson in Waltzing. I enclose 25c to pay for the postage, printing, etc.

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Heat, plenty of it, in base burner or heating stove. Clean, satisfactory, economical, convenient as steam heat. Brings happiness, plus.

Convert any cook stove, range or heater into a real gas stove. OXO-GAS, the cheapest, cleanest and most efficient fuel known to science, is made right in your own stove from kerosene or distillate and air. Burns a pure, blue flame of high heating intensity as silently as city gas.

Send for catalog illustrating and describing twenty different, distinctive designs of oil burners for *Furnaces, Cook Stoves, Heating Stoves, Base Burners, Hot Water Heaters, etc.*

AGENTS Some choice territory for **WANTED** OXO-GAS agencies still open to thoroughly responsible parties. Your own locality may yet be unassigned.

GLORIA LIGHT CO.
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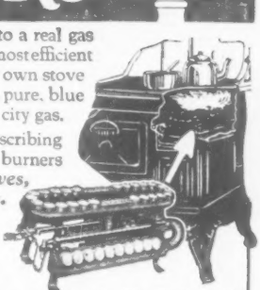

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His Iver Johnson Has Been On Duty 25 Years

READ what Mr. J. S. Van Voorhis of New Jersey has to say about the Iver Johnson Revolver:

"I have had this revolver for twenty-five years. Have used it in service as well as on riot duty—to say nothing of four years as a pocket gun—while a member of the Pennsylvania Constabulary. The fact that it has never been out of order speaks for itself."

A revolver that gives this kind of service can certainly be depended upon to stand by you should an emergency ever arise. Keep an Iver Johnson Revolver in your home as a guarantee of protection.

The famous Safety "Hammer the Hammer" Revolver—all piano wire coiled springs, heat treated; positive cylinder stop; accurate rifling, lead-lapped, insures straight shooting and maximum velocity.

Handsomely designed, finished in blue, or nickel over copper. 22, 32, 32 Special six shots, and 38 caliber hammer and hammerless models with Regular, Perfect Rubber, Pearl or Western Walnut grips.. Barrel lengths, from two to six inches inclusive.

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Catalog "B" describes Iver Johnson Bicycles for men, women, boys and girls; also Velocipedes for little children.

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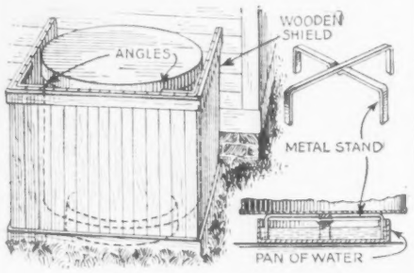
IVER JOHNSON REVOLVERS

Three-Sided Shield Hides This Antproof Garbage Can

FOUR angle irons, two lengths of strap iron, a few feet of tongue-and-groove ceiling, and six 1 by 3 in. battens, combined with a bit of ingenuity, will shield effectually the unsightly garbage can and also eliminate the dreaded all-summer army of ants in localities where ants are troublesome.

Make three sections as shown, a little higher than the garbage can. Then, to



The shield in place and details of the stand, which is set in a pan of water

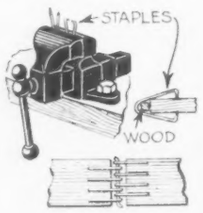
elevate the can from ants, take the two pieces of strap iron, each of which should be 6 in. longer than the diameter of the can, and bend the ends down 3 in. to form feet. Bend one iron down in the center, so that when the other crosses it at right angles the top will be level. Rivet the irons together at the center.

The garbage can rests on this iron stand, the feet of which are placed in a large shallow pan of water so that ants and beetles cannot climb up.—A. MAY HOLADAY, San José, Calif.

Belt Splice Is Made Quickly with Ordinary Staples

SMALL staples may be used for making a cheap belt splice that will give as good service for ordinary work as commercial fasteners. A pair of pliers, a hammer, and a vise are the only tools needed.

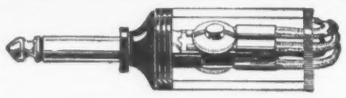
The staples, which are of the type used for fastening chicken netting, are placed in the vise and bent as shown with the pliers. Then they are fastened at regular intervals over the end of the belt, a small



How the belt splice is made

wooden stick being used as a guide to insure uniformity. When the points have been driven into the leather, the stick is removed and the other end of the belt is similarly treated. The two ends are brought together and a long cotter pin or else a piece of wire is pushed through the loops.

One advantage of this type of splice for use around the farm is that one belt may be used for many different purposes by inserting pieces to lengthen it.—J. J. B.



Nothing complicated about the DUOPLUG

It takes two headsets—and is so simple that no tools are necessary to make connections.

Unscrew the handle and look inside—you can tighten the special thumb-nut connectors with your fingers, and be assured of a secure and perfect contact.

A substantial plug—with genuine bakelite handle and heavily nickeled metal parts. Good radio shops have it—at $1.00.

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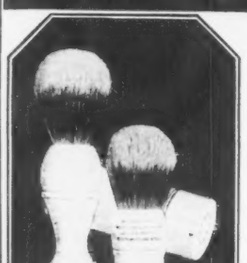
PACENT
Radio Essentials

For a Generation of Daily Use



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The satisfaction of using a WHITING-ADAMS Shaving Brush increases day by day. They *satisfy*—*serve*—and *survive!*

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It completely covers inside electrical wiring and construction in accordance with the National Electrical Code.

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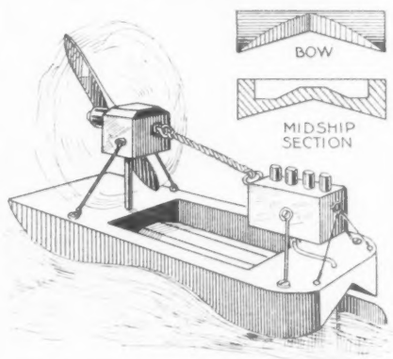
POPULAR SCIENCE MONTHLY
250 Fourth Ave., New York City

A Sea Scooter with Air Propeller Is a Novel Toy

MODELED somewhat after the style of a racing seaplane, the toy scooter illustrated, if properly constructed, will travel quite rapidly for a short distance.

A rubber band is used to turn the air propeller, but the works of a dismantled clock or a toy spring motor can, with a bit of ingenuity, be rigged up as the power plant.

The hull is fashioned from a piece of white pine 2 in. thick, 6 in. wide, and 15 in. long. The shaping is done with plane and chisel. The cockpit is cleaned out with augur bit and chisel, a half-inch ridge being left along the center—



This fascinating toy has a wooden hull shaped like that of a racing seaplane

otherwise the bottom would be too thin there.

A rudder is made by soldering a piece of tin, properly shaped, to a piece of wire, which is then placed and bent as shown.

There is considerable vibration, so it is necessary to brace very rigidly the "engine" and the part that holds the propeller. This is done by means of pieces of wire having the ends bent to form eyes, held in place by screws.

The propeller should be modeled after those used in airplanes. Soft pine whittles easily and is satisfactory. Bend the end of the shaft and fasten it to the hub of the propeller with a double-pointed tack.

Decorate the scooter after the fashion of racing boats, paint a name on the bow, and you will have built a boat that will be the envy of all.—KENNETH R. LAVOY.

Cheap Shopping Bag Serves as Emergency Landing Net

RECENTLY I found myself near plenty of good fishing and able to procure all the necessary tackle except a landing net. As a landing net is almost a necessity for a game fish hooked on light tackle, I set to work to improvise one.

REMOVE HANDLES
FORKED SAPLING
CHEAP MESH SHOPPING-BAG
SPLICE ENDS OF BRANCHES TOGETHER AND WIND WITH WIRE OR FISH LINE.
WIND WITH WIRE TO PREVENT SPLITTING
TIE BAG TO FRAME WITH PIECES OF CORD
FRICTION TAPE GRIP

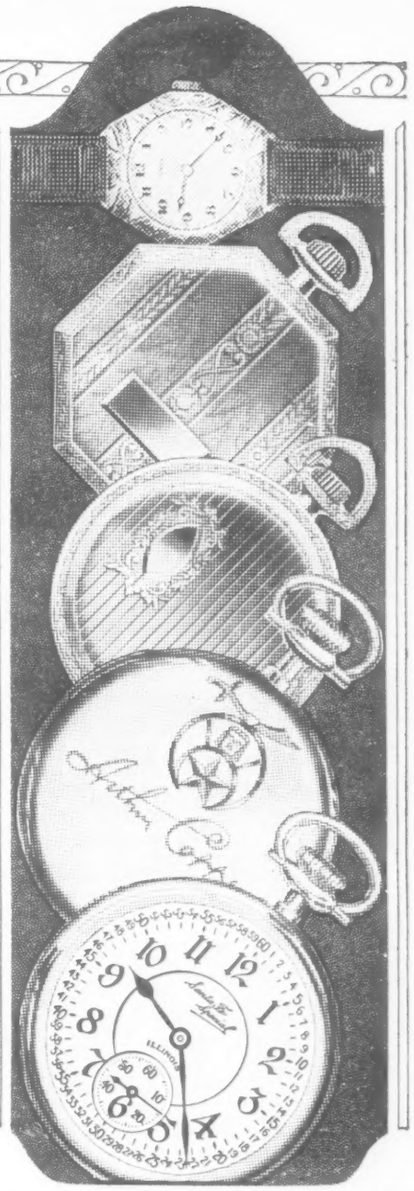
How a fisherman may improvise a net

Looking around a country store I found a 20-cent mesh shopping bag for the net. For a handle and frame I used a forked sapling of hard wood, as illustrated.—S. B.

21 Jewel Santa Fe Special

Sent on Approval

21 Perfect Jewels
Adjusted to Positions
Adjusted to Temperature
Adjusted to Isochronism
Adjusted to the Second
25 Year Gold Strata Case
Your choice of Dials (including Montgomery R. R. Dial)
New Thin Models. All Sizes.



WHILE other watch dealers are raising their prices, asking you for larger monthly payments, and making payment terms harder for you to meet, we are offering you our new model Santa Fe Special, no advance in price, no money down, easier terms and smaller monthly payments. We realize the war is over and in order to double our business we MUST give you pre-war inducements, better prices, easier terms, and smaller payments.

Send No Money Without one penny of advance payment let us place in your hands to see, to examine, to inspect, to admire, to approve a real masterpiece in watch creation. Our determination to this year double our sales of the world famous Santa Fe Special and Bunn Special Watches prompts this matchless offer.

Ladies' Wrist Watch—New Elite
This Artistic, dependable Ladies' Wrist Watch, fitted with genuine Illinois Springfield movement. A perfect timepiece. Beautiful 14 Karat **white** or **green solid gold** case. Many designs—Ask for New Watch Book showing New Elite case designs in color. Watch sent on approval and sold on payments

Page 12 of Our Watch Book Is of Special Interest to You!

Ask for our Watch Book free—then select the watch you would like to see, either the famous Santa Fe Special or the 6-position Bunn Special, and let us explain our easy payment plan and send the watch, express prepaid, for you to examine. No money down.

REMEMBER—No money down—easy payments buys a master timepiece—a 21-Jewel guaranteed for a lifetime at about half the price you pay for a similar watch of other makes. **No** money down. A wonderful offer.

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"Home of the Great Santa Fe Railway"

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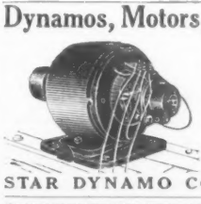

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BURGESS RADIO BATTERIES

SOMETIMES it's Dad who does the buying for his radio family, but you may be sure that that youngster of his sits in on the advisory board.

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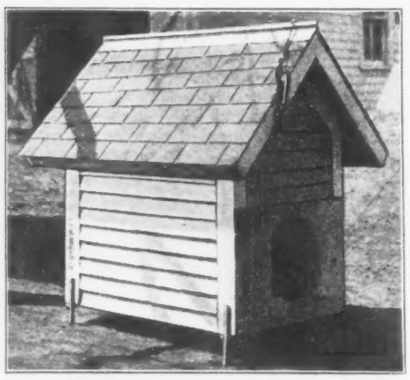
Miniature House Insures a Warm Shelter for Watch-Dog

"Can you furnish me with a good design for a dog house?" is a request received at intervals from readers of the Home Workshop Department. The excellent design shown below will answer the majority of these questions.

A GOOD dog is worthy of a good home. At least that is what one Nebraska farmer believes. So he has made for his watch-dog a small but comfortable home that is attractive and weathertight. The floor is elevated above the ground so that it is always dry and warm.

The house is 2 ft. wide and 3 ft. 4 in. long, with a shingled roof and "trim" like that of a house. One important feature



A raised floor, shingled roof, and tight joints make this a weatherproof dog-house

is the gaspipe legs, which anchor it to the ground. Some sort of anchorage is imperative, as a building so small might be toppled over in a strong wind. The pipes extend two feet in the ground and the tops are bolted to the corners of the building.

The house faces the east and is readily cleaned when necessary.—DALE R. VAN HORN, Walton, Neb.

Special Lettering Pens Made from Ordinary Steel Points

LETTERING pens, with which the amateur draftsman can do a fair grade of bold hand lettering without much practice, can be made in a moment with the aid of a pair of old shears from ordinary steel penpoints. Simply remove a portion of the point, as in Fig. 1.

Fig. 1. Cutting penpoint with old scissors

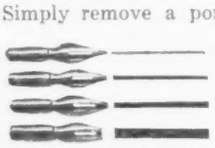


Fig. 2. A set of pens

In Fig. 2 it will be seen that the more the points are cut away, the wider will be the lettering made by the pen. Use the pens in an ordinary penholder. For ink, use writing fluid with several pinches of gum arabic dissolved in it—KENNETH B. MURRAY.

Boys! This new IVES train No. 690 is a wonder- $15.00

WHEN you see it you will be astonished that such a large, fine train, operating on No. 2¼ Gauge Track, can be sold for such a reasonable price. It represents a new value in miniature railroad outfits.

There are many splendid new features in the 1924 Ives Railway Lines. Foremost among them is the wonderful Ives electrically-reversing locomotive.

You can stop this new electric marvel, running at express speed, and then reverse it by means of the control switch located away from the track. It's the *only* toy locomotive in the world that reverses electrically.

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$19.50

THIS train is the same in every respect as No. 690, but the locomotive is equipped with reversing motor described above. *It has no equal!*

Ives Toys make happy boys

Mail coupon below for book describing and illustrating the Ives mechanical and electric trains for boys of all ages, and at prices ranging from $1.50 to $50.00. Toy, hardware and department stores sell Ives Trains.

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ELECTRIC AND MECHANICAL
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Please mail me your 32-page railroad book illustrated in colors, showing the complete line of Ives Trains, Locomotives, new Signals, and Accessories. I enclose 10 cents (U. S. stamps or coin).

Name.....

Address.....

City.....State.....

A Triumph for the Airplane

(*Continued from page 34*)

intentions of turning into a swan!

At a casual glance the Liberty motor used in the round-the-world flight today is the same motor that was turned out in huge quantities during the war. And yet it is a different motor in more than 600 vital particulars. Little refinements have transformed it from a mechanism of questionable value into an internal combustion engine of the highest efficiency ever attained.

In all Army flying since the war, whenever a motor part broke or failed, it was sent to the technical section for examination and test. And not only was the defect remedied in that particular motor, but every motor in service, and every motor thereafter placed in service was changed to conform.

THAT is the way the reliability, staunchness and durability of the Liberty motor were developed—little by little through a total of more than 600 changes, some of them trifling but tremendous in their cumulative effect. Nor was this new efficiency won without sacrifice. Many pilots and observers died martyrs to the effort to improve the Army Air Service and to point the way to the development of commercial aviation.

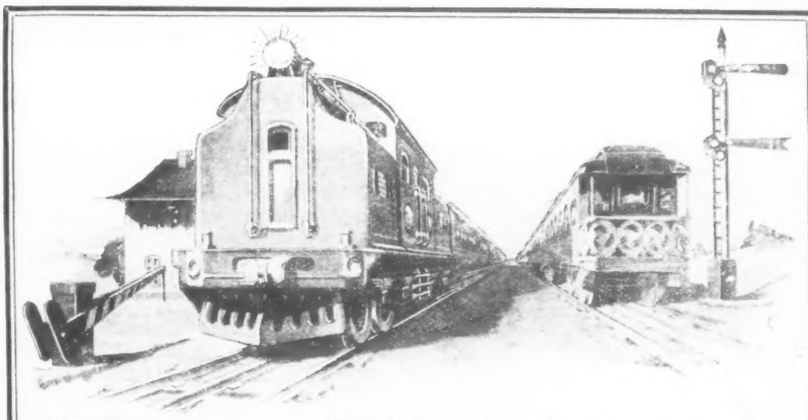
And the result? It is not necessary to look to the world flight to find it. In two years not a single plane flying from Mitchel Field has had to descend because of motor trouble. Army planes now give 98 per cent continuous performance. A plane flies for 160 hours; then, whether it shows signs of wear or not, it is overhauled and made ready for the air again. Which is equivalent to saying that an ordinary stock plane is expected to stand up for a period of flying about equal to that consumed in, say, five trans-continental flights.

Early this summer I got an idea one morning that I'd like to pay my parents a little surprise call. They live at Columbus, Nebraska, and I was at Mitchel Field, approximately 1385 miles away. I got into a stock plane of the HD model, and I took dinner at my old home that evening. Moreover, there was an hour and a half to spare before dinner. On the return trip I visited several Western cities with greater convenience than could have been obtained by any other means of transportation—and the plane has been running ever since without the slightest sign of trouble.

CAN you imagine a locomotive accomplishing any such trip as that—more than 3,000 miles, with the throttle wide open all the way, stopping only for fuel and oil? You can't, because no locomotive ever made was capable of such service. Observe the next time you take a long railroad journey with what frequency the locomotive is changed; you'll probably be astonished to note that a new engine is pulling your train every couple of hundred miles.

Of course, other phases of aviation were not at a standstill while the Army Air Service was taking the "bugs" out of the Liberty motor, as those in the service

(*Continued on page 142*)



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"LOOKS just like my Lionel, doesn't it?" That is what a boy said at the movies as the Express came rushing along the track.

Boys are always comparing their Lionel Electric Trains to *real trains* because they know how *real* Lionel Trains are. The only difference between Lionel and real railroads is the size.

Since 1900 Lionel has specialized exclusively in the manufacture of model electric railways. Lionel makes true model trains and equipment —not mere "toys."

Lionel trains and equipment are fine looking, of course, but even more important than their distinctive beauty is the engineering skill, the material and workmanship that go into their manufacture—*they are electrically and mechanically perfect.*

And this is why "Lionel Standard" and "O" Gauge Trains are far and away the most popular in America today.

You can buy a complete Lionel Train from **$5.75 up** (slightly more in the far west). See them at leading toy stores, department stores, electric shops, sporting goods and hardware stores.

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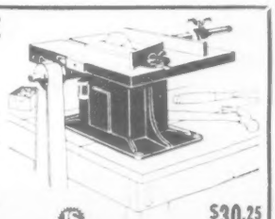

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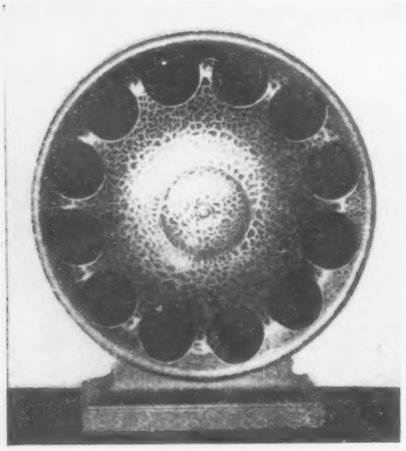

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Listen to this new invention on your own set. We authorize N & K Dealers to put it into the homes of responsible customers on

FIVE DAYS' FREE TRIAL

Price, complete with 6 foot cord, $27.50. If your dealer has not yet been supplied, notify the Th. Goldschmidt Corporation, Dept. S. 9, 15 William St., New York City, and you will be given prompt opportunity to listen to this new N & K Imported Loudspeaker.

Made by the makers of N & K Imported Phones, Model D, 4000 Ohms. Price $8.50

DEALERS:

This new Loudspeaker has made an instant sensational success, wherever displayed. It is a big profit maker because it meets every demand put upon high grade loudspeakers—tone quality, appearance, price. If your regular jobber cannot supply you, write us for name of nearby N & K authorized Distributor.

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N&K

A Triumph for the Airplane

(Continued from page 141)

describe the process of bringing about the many refinements that have resulted in its present efficiency. New equipment of many sorts contributes to the comfort and efficiency of the modern air pilot. The earth inductor compass, for example, with which the round-the-world planes were equipped, enables a pilot to maintain his course independent of fog, snow, rain, or hail.

This instrument, developed recently, is a series of coils set in opposition to the earth's magnetic lines of force and rotated rapidly to produce a current by induction. These coils are connected with a delicate galvanometer in the cockpit and are so arranged that when the airplane travels its predetermined course the coils rotate along the line of the earth's magnetism, and no current is induced. Any deviation from that course, however, will cause the coils to cut the magnetic lines of force of the earth and so generate a current, moving the needle of the galvanometer and thus permitting the pilot to see how far he is off course. It was this instrument, undoubtedly, which permitted the world pilots to pass safely through the fog and snow encountered off the Aleutian Islands.

SIMILARLY, the condenser altimeter, an ingenious apparatus that employs static electricity to enable a pilot always to determine his exact height or his exact distance from any object he may be approaching, is of prime importance in so venturesome an undertaking as a world-flight, in which the pilot is almost constantly flying over strange country.

The world-flight is an all-American undertaking in every sense of the term. Planned and sponsored by the flying arm of the country's land forces, it is carried out by soldiers of the United States Army in planes designed and constructed by an American aeronautical engineer—Donald Douglas—and that get their power from an engine the development of which is a triumph of American ingenuity, industry and patience.

The Douglas World Fliers, as the planes are called, are a modification of the Douglas torpedo plane. A thicker wing section, demountable pontoons that permit the planes to land on, and take off from water as well as land, and other body refinements fitted the Douglas machines for their epoch-making journey.

HARKING back to the days of Cal Rodgers and his 54-day transcontinental flight, and recalling the progress in aviation since then, what predictions can be made for the next dozen years? Will men of the air girdle the earth as casually as they now pass over a dozen states?

I hesitate to make a specific prophesy. One thing I will say, though, in full confidence that my prediction will be fulfilled. That is, that no matter what developments in aviation come in the future, Americans then, as now, will stand forth the leaders of the world.

Next month—A remarkable pictorial story of the Navy's new peace airship *ZR-3*, and her warlike sister, the *Shenandoah*.

Irresistible!

You can be expected, anticipated, welcomed with open arms. You can be a favorite at parties, dances and other social affairs.

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It's all fun, and even though you're only interested for pleasure now, you can, in 90 days' time, join a band or orchestra, if you wish.

First class Saxophonists make big money. Try it free for six days in your own home.

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You Can Save Your Wife 10,000 Steps a Day

(*Continued from page 82*)

material. Here is where the experienced architect, builder and dealer know how to save hundreds of dollars. If all the dressers, the breakfast nook, table and benches, and other woodwork have to be made specially at the mill or in part, at least, by the carpenter on the job, the arrangement is not practical because the cost is disproportionately large.

Two families that I know of each are building a house from the same architectural plans and in the same city. The details for special built-in woodwork were drawn to scale carefully by the architect and were reproduced in the blueprints. The head of one family had his contractor order all of this specially designed woodwork specially turned out at a local mill. In the other family, the housewife studied various stock woodwork or millwork catalogs and bought stock designs of built-in furniture that closely resembled the architect's designs. The difference in cost saved her about $250, and about $100 of this saving was in the built-in kitchen equipment.

THIS woman discovered that in every lumber dealer's stock a wide variety of millwork is available, and that designs and sizes which are not in stock can be ordered from catalog. In any type of stock woodwork there is an unexpected range of choice in dimensions and style. Dressers, for example, may have glass or panel doors, and they may extend to the ceiling or not as you wish. Bins and drawer sections are interchangeable so that almost any desired combination is possible. Used singly or in group assemblies, such units will fit into compact space in kitchens already built, as well as in newly constructed kitchens.

Most architects and builders now provide comfortably sized kitchens for their clients. A builder of small houses who has sold more than 2000 five-, six-, and seven-room homes during the past two years told me recently that women prefer a kitchen containing from 100 to 150 square feet, with plenty of built-in convenience and labor-saving features. This space, he has found, allows room, without crowding, for the equipment needed for the many household tasks that center in the kitchen, yet does not involve miles of walking for the worker. Unless the popular separate dining nook or breakfast alcove is provided, the kitchen should be large enough to be used for breakfasts and other informal meals.

IF your house was put up before built-in devices came into general use, you still may install some of them without costly alterations. Not long ago when I went to dinner at the home of a middle-aged couple, I observed that my hostess was limping slightly.

"Have you met with an accident?" I inquired.

"Yes." she replied, "That dratted ironing board! It just fell out of the kitchen closet on my foot."

(*Continued on page 144*)

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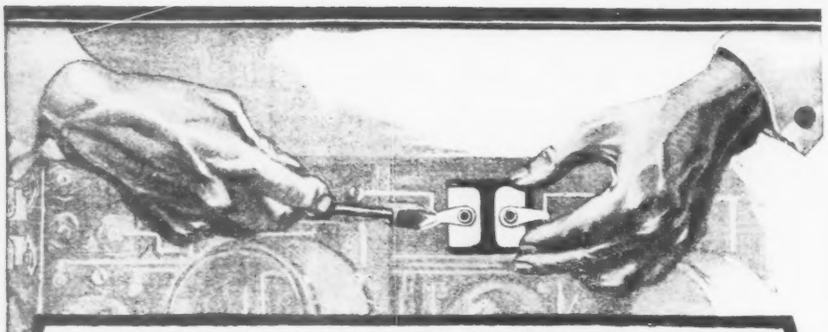

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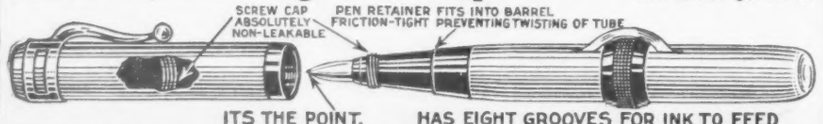
New Self-Filling Bamboo Fountain Pen with Stylo Point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You Can Save Your Wife 10,000 Steps a Day

(*Continued from page 143*)

"Why don't you have a built-in ironing board installed?" I suggested.

"In this old house?" she asked.

I explained that to install such an ironing board in an old building, all that is necessary is to cut out lath, plaster and baseboard between two studdings that are about sixteen inches apart, to a height which will take the stock cabinet containing the hinged ironing board. First, of course, make sure that there are no obstructions such as pipes or wires between the studding to prevent the cabinet from going back the proper depth, about six inches. Nails fasten the cabinet in place between the studs. The stock door casing, door cap and door then can be hung.

My hostess followed my advice. On my next visit she led me out into the kitchen. There, practically flush with the wall, was a six-foot cabinet. She opened the door, and pulled down the large board, revealing a smaller board hinged just above.

"There they are, as you see," she said, "the big and the little. They are always in place; never fall down; are never in the way; require neither chairs nor table for support; are clean and free from dust, and are always ready for use. For convenience I have had an electric outlet installed next to the cabinet." White enameled, it perfectly matched the other woodwork in the kitchen.

MOST manufacturers of stock millwork and built-in furniture and equipment furnish the material assembled or partially so, in the natural wood, so that it can be finished on the job to suit. Hardware sometimes is supplied with it. Always buy good hardware. Inferior, cheap hardware, quickly rusts. Bronze or brass hardware is best and cheapest in the long run.

There is nothing mysterious about built-in kitchen equipment. It has come to stay. Moveable kitchen units, of course, are avilable in both wood and steel; but the built-in kind seems to be steadily gaining in popularity in the average man's house today.

As an integral part of the house, these built-in features—particularly for the well equipped and well-planned kitchen—very often sell the house, builders find. Every man and every woman constructing a home should remember that one day it may be necessary or desirable to sell that house. Details that lend comfort, convenience and attractiveness combine to create a better home that should not be hard to dispose of almost any time at a good price.

WHY it is economy to build in permanent furniture in other rooms of your home—whether you are planning a new house or building over an old one—will be discussed by Mr. Moore in an early issue. He will show you how you can do it and will explain why built-in furniture increases floor space by taking its place as part of the wall, increases property value, and is useful, practical and decorative.

Do You Sleep Too Much?

(*Continued from page 43*)

most relaxed, your blood pressure lowest, and your skin sensitivity least.

After the first couple of hours, sleep becomes lighter, After four hours it is very light. The slightest noise will awaken an average sleeper after this time.

Now, to continue this light sleep in the morning is not restful. The extra hour's sleep usually is made up of short naps—broken sleep. It is beneficial neither to your body not your mind. On the contrary, it is likely to do you grave harm by helping build up a habit of laziness.

WHY not, then, do away with this light, fitful slumber that does you no good, and substitute deeper sleep of shorter duration? Cut two or three hours from your night's sleep and still obtain more rest than you do now?

You can do it very easily if you can manage to take a noonday nap of less than an hour every day. You are usually drowsy at this time, and apparently nature intended you to sleep then. Forty-five minutes of deep, restful sleep at midday is equal to three or four hours of the light sleep you get from three to seven in the morning.

If you can take this noonday nap, follow it with a short period of light exercise, such as rapid walking, to aid digestion. It may take you a few days to accustom yourself to sleeping during the day, but within a week you should be able to do it easily, and you will find yourself able to cut three or four hours at least from your night's sleep and still be stronger and more efficient both mentally and physically.

Of course, I realize that it is difficult, if not impossible, for some people to take a nap at noon. Those who can't, will find themselves improving the quality of their night's sleep if they will follow a few simple rules for sleeping.

To begin with, restful sleep depends on *entire relaxation of the body*. The only way you can relax entirely is to lie at full length. Some animals can sleep standing up, but human beings seldom attempt anything like that. Still, I knew a man, several years ago, who would sleep while standing by his bed. There must be something wrong with a man like that, you are thinking. Very likely. When I knew him he was a patient in a hospital for the insane, which is about where all of us would end if we tried sleeping the way he did.

PROBABLY you would find it impossible to do as he did. Muscular relaxation is so essential to the sleep of human beings that you can prevent yourself from sleeping by clenching your fist or bunching the muscles of your legs or arms. Conversely, you can coax sleep by relaxing every muscle of your body—your arms, legs, trunk, neck—even your ear muscles.

The best way to do this is to sleep partly on your side—either side—and partly on your stomach. To sleep on your side will not permit entire relaxation, for some of your muscles must be kept tense to prevent you from rolling out of bed. Neither

(*Continued on page 146*)

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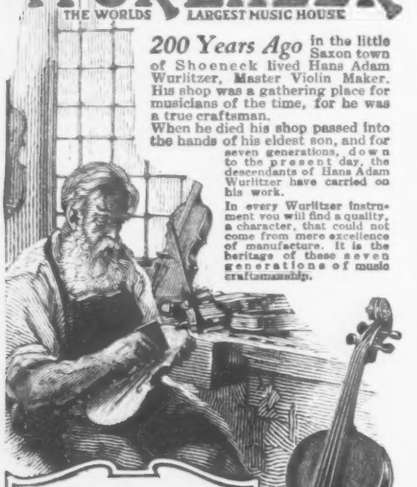

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Do You Sleep Too Much?

(*Continued from page 145*)

can such complete relaxation be obtained by sleeping on your back. In this posture, gravity will cause your lower jaw to drop and your mouth to open when your jaw muscles relax. This will cause you to snore—loudly enough possibly to awaken yourself or others.

Not that snoring is an evil accompaniment of slumber. On the contrary, it is a sure sign of deep, restful sleep. You can avoid snoring, however, and still get quite as much muscular relaxation and quite as much rest if you will sleep in the position I have mentioned. This is one of the very likely ways of causing the morning "tired feeling" to disappear.

BESIDES muscular relaxation, the other prime requisite for sleep is *monotony*. Excitement prevents slumber and causes bad dreams. Indeed, the excitement that usually accompanies evening gatherings probably is the cause of the nightmares that most people attribute to something they have eaten before going to bed. The deep sleep of old people and people who live in the country can be attributed to their monotonous existence.

The best way to obtain monotony is to sleep in a quiet room. Yet quiet is not absolutely essential to monotony. Regularly repeated sounds, such as the incessant ticking of a clock, are monotonous. They are good instigators of sleep—after you become accustomed to them. The muffled ticking of a watch underneath your pillow will help you to sleep.

Extraordinary sounds, though, tend to awaken you. You *can* learn to sleep in a boiler factory and find the constant uproar conducive to sleep. But a comparatively slight noise—the passing of a trolley car or an automobile, or the footstep of some one near your bedside—raises your blood pressure immediately and is likely to awaken you if you are not sleeping deeply.

The next most important consideration in seeking deep, restful sleep is *comfort*. A soft, comfortable bed, a soft, comfortable pillow to raise your head and prevent the blood from rushing to your brain, and covers that are sufficiently warm without being too heavy are essential to sound sleep. A hard bed, a lumpy mattress, or very heavy covers cause uneven pressure on the body. They are irritants, and tend to make sleep light.

WITH these aids—muscular relaxation, monotony, and comfort—you soon can teach yourself to sleep deeply, very quickly. Within a short time you will find that six hours' sleep is enough for you. During my recent investigation of sleep I taught many persons how to sleep properly and how to cut down their hours of sleeping.

You cannot, however, make up your mind today that hereafter you are going to get along with six hours' sleep, and put that schedule into effect tonight. You would find that harmful, especially with regard to your ability to do mental work.

(*Continued on page 147*)

EARLE E. LIEDERMAN
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Can you do any of them? I can and many of my pupils can. It is remarkable the things a man really can do if he will make up his mind to be strong. It is natural for the human body to be strong. It is unnatural to be weak. One leading writer on physical culture says: "It is criminal to be weak." I have taken men who were ridiculed because of their frail make-up and developed them into the strongest men of their locality.

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A DOCTOR WHO TAKES HIS OWN MEDICINE

Many say that any form of exercise is good, but this is not true. I have seen men working in the factories and mills who literally killed themselves with exercise. They ruined their hearts or other vital organs, ruptured themselves, or killed off what little vitality they possessed.

I was a frail weakling myself in search of health and strength. I spent years in study and research, analyzing my own defects to find what I needed. After many tests and experiments, I discovered a secret of progressive exercising. I increased my own arms over six and a half inches, my neck three inches, and other parts of my body in proportion. I decided to become a public benefactor, and impart this knowledge to others. Physicians and the highest authorities on physical culture have tested my system and pronounced it to be the surest means of acquiring perfect manhood. Do you crave a strong, well proportioned body and the abundance of health that goes with it? Are you true to yourself? If so spend a pleasant half hour in learning how to attain it. The knowledge is yours for the asking.

Send for my new 64-page book
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It contains forty-three full-page photographs of myself and some of the many prize-winning pupils I have trained. Some of these came to me as pitiful weaklings, imploring me to help them. Look them over now, and you will marvel at their present physiques. This book will prove an impetus and a real inspiration to you. It will thrill you through and through. All I ask is 10 cents to cover the cost of wrapping and mailing and it is yours to keep. This will not obligate you at all, but for the sake of your future health and happiness, do not put it off. Send today—right now, before you turn this page.

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Do You Sleep Too Much?

(*Continued from page 146*)

In one of my experiments I found that persons who have lost two hours' sleep are unable to work as well on the following day. The reason for this is that they are forced to use more than their accustomed amount of energy in accomplishing any of their usual tasks. With the loss of a whole night's sleep mental efficiency is lowered by as much as 25 per cent.

In fact, doing without sleep is more dangerous than doing without food. A dog can be starved for 20 days. It will lose weight, but will recover rapidly when fed again. To deprive a dog of sleep for five days, is fatal. With men virtually the same thing holds true.

PROFESSOR G. T. W. Patrick, of the University of Iowa, not long ago kept three men awake for 90 consecutive hours—virtually four days. At intervals he gave them psychological tests to measure their working efficiency in various mental functions. Their memories were affected particularly. After 72 hours without sleep it took one man 20 minutes to commit to memory a selection similar to one which he had memorized in a little more than 2 minutes before losing sleep. After 86 hours, he could not memorize at all!

Another man began to "see things"—colored insects which he tried to kill. All of the men suffered immeasurably.

However, you need not be afraid that something like this will happen to you if you learn to dispense with two or three hours' sleep a night by learning to sleep deeply. The subjects I used in my investigation all were accustomed to eight to nine hours' sleep a night. Now they get six.

They discover that the shorter sleeping time not only is giving them more time for work or play, but actually has increased both their mental and physical efficiency.

This is not guesswork. Scientific tests of the body metabolism and mental efficiency that each man underwent before breakfast during the investigation show that this increase in efficiency undoubtedly has taken place.

If you are going to cut down your sleeping time, make the reduction from the night end of the sleep period. That is, stay up later and rise at your usual time. When this is done, the deeper sleep that you get when you go to bed seems to compensate for what you have lost.

Remember—it is not how *much* sleep you get that counts; it is the *kind* of sleep. Are you getting enough of the right kind? Or do you get too much poor sleep?

DID you know that one out of every 10 persons in the world suffers from defective hearing of some sort? How well do *you* hear? Perhaps you are partially deaf and don't know it.

In an article next month a distinguished expert will tell you how to test your hearing, and how to safeguard yourself from the tragedy of living in eternal silence.

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What I Learned About Old Age

By Byram C. Kelley, A.M., L.L.D.

CERTAIN new facts about old age, recently disclosed to me, constitute the most startling information I have ever received. I am 40 years old myself. I had begun to wonder if I would soon begin to "break"—to lose my old-time pep and aggressiveness, my stamina and resistance to disease. I wondered if I would soon be subject to the class of ailments which seems so prevalent among men past 40. Then through a mutual friend, I made the acquaintance of a member of the American Association for the Advancement of Science, who has recently brought to light most interesting facts about the peculiar conditions common to men past middle age.

Why Many Men Are Old at 40

I had often wondered why so many men begin to lose their vigor and alertness when they are scarcely out of their 30's—yet others, at 60 and 70, seem to be in the prime of life. There must be some reason for this difference. And I found out exactly what this reason is.

65% Have Gland Trouble

I have learned that 65% of all men past a certain middle age have a disorder of a little gland, called the prostate. And prostate disorder is not only the direct cause of much distress, often necessitating operation, but it displays itself in many parts of the body, mental as well as physical.

Common Middle Age Ailments

Here is an important cause for many ailments which heretofore have been simply taken for granted as "old age" symptoms—sciatica, aches in back, legs and feet, frequent nightly risings, nervousness and irritability and frequent dizzy spells indicating high blood pressure; and I learned how, by an astonishingly simple new method, that these disorders would be eliminated in many instances in a short time, without drugs or operation—a treatment that reaches this gland directly—yet is so convenient that any one can apply it in their own home.

10,000 Men Find Relief

73 Years Young

But most surprising of all, I find that 10,000 men have already found relief. Statesmen, bankers, lawyers, doctors, in every section of the country are using and endorsing the method. I read many letters. One was from a man in Colorado. "73 years young is my age," he wrote, "yet for years I suffered with prostate trouble. Used medicine to no avail—had about given up hope, when a doctor recommended your treatment." Just think of a man 73 years old being restored to the health and buoyancy of youth! And it is within the reach of every one. There are no drugs, no books, no electric rays.

All Explained in FREE Book

If you are troubled with any of the disorders mentioned, if you have chronic constipation or prostate trouble, you should send for a vitally interesting free book, written by this scientist, called "Why Many Men Are Old at 40." It describes this splendid treatment and shows how you may regain much of your youthful vigor and be free from certain disorders. No obligation. But write at once—the edition is limited. Simply mail request to **The Electro Thermal Company, 4038 Main St., Steubenville, Ohio,** the concern that is distributing these books for the author. Western office, **Dept. 40C, Los Angeles, Calif.**

A New Era in Auto Construction

(*Continued from page 37*)

a record of everything he does to the car on the road—every turn of a wrench or screwdriver is put down. If during this interval repairs are necessary in the garage, a detailed record is kept.

"Then at the completion of 25,000 miles of this strenuous pace, in about three months, the car is taken down and measurements and tests made to determine the wear of parts, the fatigue of metals, and other scientific data. In this work the most exact instruments and devices are employed. Then from this information we set to work to improve or strengthen the parts that show the need.

"THESE cars sometimes carry sandbags equivalent to the weight of four or five passengers. In road-testing a five-ton truck, it is loaded with six or seven tons of gravel and otherwise subjected to extreme conditions. A scientific device determines the fatigue limits of metals. Like a piece of pasteboard, metal will give and take within its elastic limits, but eventually will break."

I had the rather freezing pleasure of stepping out of a Dayton summertime into a temperature 20 degrees below zero, in which experiments were being made with the performance of carburetors, self-starters and ignition systems. The refrigeration room is big enough to hold an automobile, and when the big doors are closed and the recording devices outside connected, the results can be watched in comfort. Motor-cars must be made to run in winter, so all designs must be checked for temperature.

Again, on my own responsibility, it seems not too much to predict that some day we may have a carburetor that can start an engine smoothly and quickly in the coldest weather.

There is another kind of science that has played a tremendous part in the development of the automobile industry. This is the science of the mechanical engineer, supplemented by the achievements of the production engineer.

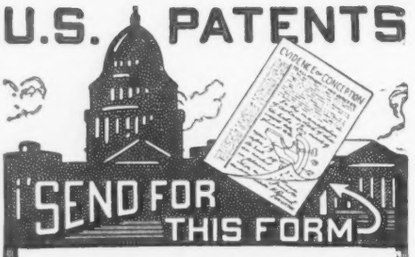
Up to 1910, automobiles were made under mechanical conditions that were primitive as we now see them. Holes were bored one by one, men wielded hand screwdrivers and wrenches, and 10 or 12 husky laborers were used to perambulate an automobile body to an elevator.

TODAY the multiple drill scoops out dozens of holes from four directions at the same time. The power screwdriver completes in a few seconds what hand power required a minute or two to accomplish, while another device fastens 18 or more nuts at one twirl.

And now mighty cranes and other conveying mechanisms take over the work of hundreds of men. One such machine, traveling under the steel rafters of the factory roof, actually moves in four directions at the same time, reaching out with its various arms like a giant octopus. The great lifting magnet reaches down and takes out a carload of steel at one motion.

(*Continued on page 149*)

U.S. PATENTS



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A New Era in Auto Construction

(*Continued from page 148*)

Monster presses come down on sheets of metal and—presto!—a whole fender is made. One of these great presses, operated by two men, does the work formerly accomplished by 40. A steam hammer with a 7000-pound blow eliminates the labor of dozens of blacksmiths.

It was once the custom to assemble automobiles by gathering the parts and setting them up as a child stirs up his box of blocks and builds a house. One of the most sweeping changes in automobile production was wrought when the present method of assembling under motion came in.

The automobile grows as it moves slowly through the factory on a traveling rack that runs on rails. Certain parts must be attached when the car reaches specified stations on the route. Every man has prescribed work to do. If greater production is required, the speed of the traveling rack is increased and more men put on.

A THOUSAND men now produce three or four times the cars they did. In some operations months are actually crowded into days.

"Here in Dayton," Mr. Kettering said, "we use the most exact instruments for experimenting with the physical properties of metals. We can take almost any piece of steel and pull it apart as you might stretch and break a rubber band; an instrument measures and records the pulling power required, be it 200 or 200,000 pounds.

"We determine the hardness of steel by dropping upon it from a predetermined height a very hard steel ball. We calculate the resistance by the rebound.

"IN another room of our laboratories we conduct microscopical studies of steel. The internal structure tells us many things pertaining to strength, hardness, and all the qualities necessary to the particular uses. The microscope may reveal overheating in forging, for instance, or impurities.

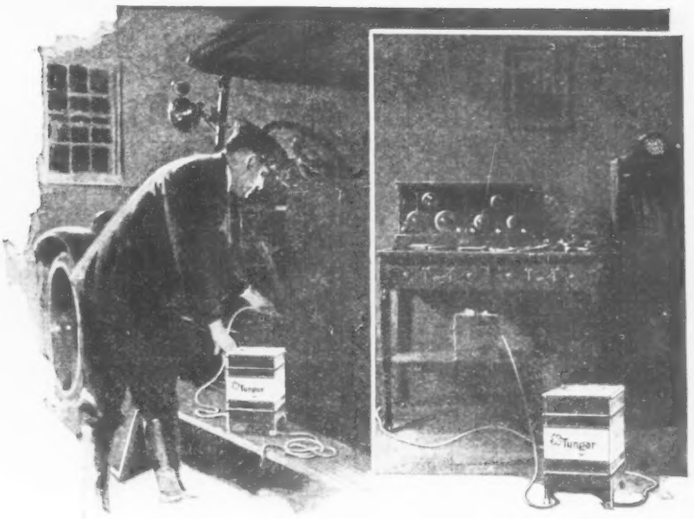
"We make microphotographs of the inside of the metal, showing the molecular formations magnified hundreds of times.

"There are many wonderful instruments for checking the accuracy of ammeters and speedometers, determining the horsepower of engines, and getting other scientific data.

"But don't forget that the machine we are experimenting with is already marvelous beyond conception. For instance, the engines of some cars fire 16,000 shots a minute, while the most rapid firing gun fires less than 1250. Every one of these 16,000 explosions is caused by a spark delivered on schedule time.

"This is the wonderful machine we are seeking to improve."

THIS is the second of a series of forward-looking articles by Mr. Woolley on what science is doing for modern industry. The third will appear in an early issue.



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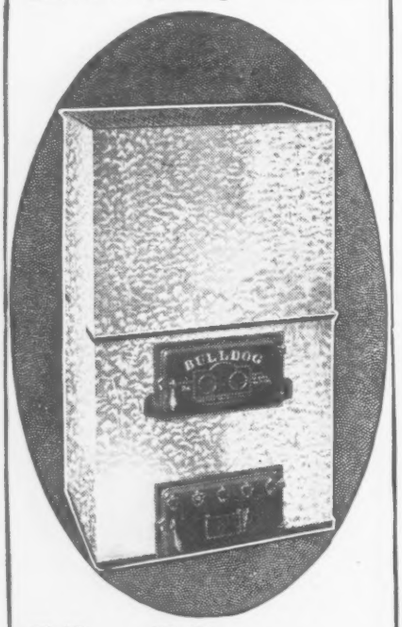
"I can run my Bulldog furnace steady for fourteen days in normal weather conditions ***on the actual cost of fifty cents.***" So writes F. R. Redetzke, of Cleveland, North Dakota, and he adds: "Hard to believe, is it? That's what some of my neighbors thought until I showed them! We have an unlimited amount of grain screenings in this country. That's the fuel I am using."



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No matter what the depth of your basement or cellar may be — the Bulldog fits it. The adjustable casing (another common sense feature) takes care of this.

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Babson Bros.

19th and California Ave., Dept. 13-67 Chicago

Without obligating me in any way, please send me your free catalog and special offer on the Bulldog Pipeless Furnace.

Name _____

Address _____

Why Animals Understand

(*Continued from page 51*)

Quickly contract the throat and inhale with the same whistling squeak with which you began. Repeat this four times and you have the complete salutation of the zebra when he "he-haws."

The domesticated donkey really says "haw-he, haw-he, haw-he." He gives the long sound of "haw" in exhalation first and whistles with his contracted throat each time he inhales between "haws." In imitating the bray of either the donkey or zebra, the prolonged sound upon exhalation should be given a slight nasal quality.

IF you find monkeys amusing, you will enjoy being able to chat with them in their own "dialect." In addressing monkeys or apes, friendly sounds must be accompanied by appropriate facial expressions. Give a guttural staccato grunt, open your eyes wide, raise your eyebrows and protrude your lips, making a clucking, kissing sound. If Mr. Monk responds by raising his eyebrows and then lowering them in a frown, you may just as well drop the conversation, because he is in a surly mood and it is useless to coax.

After you gain confidence in your ability to make animals answer you, you will probably want to make the lion roar. Breathe in as much air as your diaphragm will permit. With contracted throat give the sound of "ou" as in "you." Prolong this in imitation of the long growl of the lion, as if you were in pain. Then suddenly open the throat and rattle the palate. An ordinary lamp chimney, used as a megaphone, will give volume to your "roar."

The pigeon is one of the most affectionate of birds and learning to imitate its "coo" will give you many new bird friends. The sound of "oot," as in "root," is the primary sound in the pigeon's call. Give a long "oo" then shove the tongue forward, quickly, between the teeth until it touches the lips. This cuts off the air, producing the sound of "oot."

Practise this several times. Now, try to form the lips in an oval shape and make a gargling sound with the back of the tongue as you make the "oo" sound; complete the call with the forward motion of the tongue. Repeat this a dozen times, then fill your pockets full of cracked corn and go out and call a flock of pigeons and see what happens.

Familiar to all bird lovers is the call of the robin. Listen carefully to his whistle. You can imitate him by curving the tongue up in the palate back of the teeth and whistling with an exhalation as in "ha ha ha."

THE crow is justly known as a wise old bird. His "caw" is not pretty, but you will find it easy to imitate and very responsive. When you call a crow, a flock is sure to come, so take refreshments enough for all and you will find them an entertaining company.

By the time you have perfected the bird and animal sounds I have described, you will find many new suggestions in the fields and woods, the park and the zoo. When you begin to speak their "languages," you will find innumerable shy creatures ready to be friends with you.

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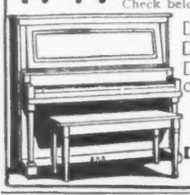

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ROYAL SALES CO,. Desk 937, Norwalk, Conn.

The Most Accurate Man

(*Continued from page 45*)

measurement comes into play in making each individual part of the gage precise to the ten-thousandth.

For example, if a part is required with a length of 2.0165 inches, the rules of standardization insist that it must not be 2.0168 or 2.0162, but as closely as possible to 2.0165. Modern machinery is made with a tolerance as close as two ten-thousandths. That, for instance, was the tolerance allowed in the vital parts of the Liberty motor for airplanes.

By the use of the Hoke gages it is possible to make parts with this precision and to be sure that they will fit precisely into mechanism of the most complicated and delicate character.

Naturally I was curious to learn where this master of accuracy found his starting point for his method of hair-splitting.

"When the war broke out," he told me, "I had been working for 10 years on my notions of the new standards. Blocks of great accuracy had been made in Sweden, but the methods had been kept secret. My first results were discouraging, but the experience stood me in good stead when I sought to demonstrate my method to the government at the outbreak of the war. The Bureau of Ordnance and the Bureau of Standards became interested and the latter gave me a place to work and a man to help me. Within two or three days we had rigged up a machine out of some old junk, for making gage blocks. A few days later we had turned out a set of blocks of one size. Tested by any known instruments these were not convincing, but optical measurements by the Bureau of Standards showed them to be of identical size and accurate to a degree that amazed the experts. Tests with the interferometer, a machine that uses light rays for measurement, showed accuracy never before conceived—within millionths of an inch."

THE use of light rays for measurement is a fascinating process. Hoke gave me an idea of the action of the rays by using one of his gage blocks and a piece of optical glass—glass ground to exact smoothness and precise uniformity of thickness. He placed the highly polished bit of steel against the surface of the glass and had me look down upon the steel through the glass. I saw a rainbow—a spectrum of parallel lines. This indicated that the surfaces of steel and glass were not parallel—that there was a wedge-shaped space between them, widening toward one edge. The distance between one green line and another, in the spectrum, represented ten-millionths of an inch of variation in the wideness of this space.

Hoke then applied the steel block more accurately against the face of the glass, by exerting a wringing motion. The colors disappeared and the metal became steely blue, denoting perfect contact.

The Hoke precision gages are the outgrowth of a life passion for accuracy. In boyhood it was not enough for him to know that his walk to school took "12 or 15 minutes." He figured it in seconds and

(*Continued on page 152*)

"I Never Knew It Was So Easy —to Learn Music!"

"THREE months ago I couldn't have believed that I'd be playing the piano today—why, I didn't know the first thing about music. Never having taken a lesson in my life, it seemed there wasn't a chance of my actually ever learning to play.

"All the time I thought they had that natural ear for music which I lacked, so I never asked them how they did it. Then one day quite by accident I heard of the short, simple home-study course of the U. S. School of Music.

"Well, do you know, I sat down that very night and wrote the U. S. School of Music. Here was the thing I had waited for all my life.

"In three days I received the School's interesting book. And after reading letters of praise from some students, I was completely sold on the whole idea and wrote at once for my first lessons.

"Everything about them was so simple and clear that a child of eight could understand it. I'd read over the Print-and-Picture instructions, which made everything as simple as A, B, C—and then I'd sit down to the piano and play another of the School's beautiful selections. It was real fun—every bit of it. No practicing long, dull exercises—no discouraging bother with monotonous scales—no tricks, no "numbers," no makeshifts of any kind.

"And in exactly three months' time I was able to play a large number of my favorite songs. I feel sure that before very long I'll be able to play any piece of music I want to—thanks to the best music school on earth, THE U. S. SCHOOL OF MUSIC."—D. L. King.

This story is like that of thousands of men, women and children. If you are anxious to learn to play—or to sing, write at once for our free booklet, "Music Lessons in Your Own Home." With it will be sent an illustrated folder, which proves better than words how delightfully quick and easy this famous Print-and-Picture Method is—whatever instrument you may be interested in. If you act at once you can take advantage of a special reduction in our courses, which we will be pleased to explain. But do not delay. Mail the coupon now. U. S. School of Music, 810 Brunswick Building, New York.

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Note These Records

Ted Gnau made $37 a day for four months. Arthur Jost $660 a month. Gratz $6000 in less than a year. Heator $124 first week. Barnes 47 orders one month. The Serenola is going over big. Factory increase over 400 per cent. Get into this big profit making business. No capital needed. No Collecting. No delivering. **Your money every day.** Write for sales plan.

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He takes his pipe 1800 miles into China

No, it isn't because his wife objects to his smoking in the house. We don't know that he has a wife, for that matter.

Mr. Mellor takes his pipe far into the interior of the Land of Confucius because he is attached to the good U. S. S. Palos, which, among other waters, sails the upper Yangtse Kiang.

This is what Mr. Mellor writes:

U. S. S. Palos
Chung King, China
January 24, 1924

Larus & Bro. Co., Richmond, Va.
G. S. Schloss,
Dear Sir:

I have just been reading a letter that was sent to our canteen yeoman and thought that this would be a good time to tell you of our appreciation of the fine tobacco that your firm shipped us. I feel that I can say the same for the crew of this ship.

Yes, this sure is an out-of-the-way place and we sure enjoy a good smoke. We feel that we can at least rely on your tobacco always being fresh, especially that in the glass jars.

This ship is now eighteen hundred miles in the interior of China on the upper Yangtse Kiang. One of the greatest pleasures we have is riding ponies out in the hills surrounding Chung King; and there is hardly a man but what carries one of your small tins of tobacco with him on these trips. Every man on the ship smokes Edgeworth and quite a few chew it too.

Speaking for all hands and the ship's cook I can say that we will uphold your fine tobacco on this part of the river as every man is for Edgeworth first, last and always. Best regards to Edgeworth from the crew of the U. S. S. Palos on the Yangtse River.

Sincerely yours,
(signed) Robert N. Mellor.

If you would try before you buy, let us send you free samples of Edgeworth and give you a chance to learn at first hand why so many smokers like it.

Write your name and address to Larus & Brother Company, 59 South 21st Street, Richmond, Va.

Edgeworth is sold in various sizes to suit the needs and means of all purchasers. Both Edgeworth Plug Slice and Ready-Rubbed are packed in small, pocket-size packages, in handsome humidors holding a pound, and also in several handy in-between sizes.

We'll be grateful for the name and address of your tobacco dealer, too, if you care to add them.

To Retail Tobacco Merchants: If your jobber cannot supply you with Edgeworth, Larus & Brother Company will gladly send you prepaid by parcel post a one- or two-dozen carton of any size of Edgeworth Plug Slice or Ready-Rubbed for the same price you would pay the jobber.

The Most Accurate Man

(*Continued from page 151*)

trained himself to cover the distance in exactly the same time, to the second, each day.

The boyish passion for accuracy caused him to know that his fishing line measured five yards, some inches and certain sixty-fourths—I have not yet arrived at that degree of accuracy where I can remember the exact measurement he gave.

WHEN he took the family sewing-machine apart, the boy of 11 first made a diagram with pencil on a sheet of wrapping-paper, showing the outfit as it stood. Spreading this paper on the floor, he deposited each part, as removed, on the spot corresponding to the proper place in the works of the machine. To prevent the screws from rolling, he stuck them through holes in the paper. In this way he succeeded in putting the machine together again without one part omitted.

He was always timing something. If a train were 43 seconds late, he would comment on the fact. If the morning schoolbell rang five seconds ahead of time, he knew it and secretly rebelled. Today he is looked upon by his fellow members of the Baltimore Yacht Club as a necessary evil; necessary in that his timing of races is the official standard of accuracy; and an evil in that he has a habit of showing that the boat reputed to sail 15 miles an hour never exceeds 12¾.

"Measurement is the fundamental of manufacture," he told me. "The use of precision gages has made possible mechanical operations that formerly were out of reach. Swiss watches formerly were made by hand. Today they can be turned out by machinery with greatly increased accuracy. Particular people used to insist on hand-sewed shoes. Manufacturing precision now makes it possible to turn out millions of shoes that are better than the individual hand-sewed type.

"AS A result of precision we now are able to produce new forms of automatic machinery. The unskilled workman is able to produce things once possible only to those of the highest skill. Today the skilled mechanic is needed only for the production of the machine by which accurate parts are made. The unskilled mechanic can do the rest.

"The new accuracy in parts has revolutionized every phase of mechanics. Human life is safer because accuracy in the parts of an automobile prevents disasters that would result from a lack of precision. Money is saved in vast volume because of the new possibilities in quantity production. By precision, the life of a machine is lengthened in that spotty wear, resulting from unevenness, is wholly eliminated."

NATURALLY I wondered if Hoke intended to elaborate his gages to less than a millionth of an inch.

"For the present," he told me, "the measurements are far ahead of the requirements. It is easily possible, however, to carry them as far as we please. When finer measurements are needed, we'll have them."

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THAT contains everything complete for assembling two stages of audio frequency amplification. The panel is drilled for three tuning units, which together with this No. 501 Kit will complete a radio set using your favorite hookup, or most any other that you may desire to try.

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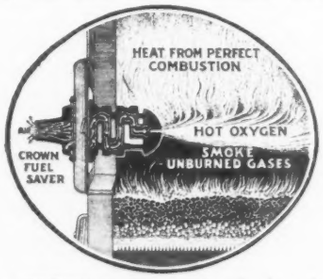

The CROWN Fuel Saver fits the feed door of any heating plant. This scientifically-designed device provides, by means of natural draft, the supply of pre-heated air, necessary to burn the "smoke" and gases that usually escape thru the chimney. (See illustration.) This gives amazing results—a slower fire, less ashes, more heat, and steadier heat on the minimum of coal. If you want *real* comfort this winter, smaller coal-bills and less furnace worries, write for details and *special* low price of CROWN, with money-back guarantee.

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$25.00 in Prizes

See top of page 6 in front of book for full details

Lights Aid Happiness

(Continued from page 57)

atomic radiation exemplified by radium and its family.

It is a fascinating picture. The atom of radium or of a relative, containing its "solar system" of electronic bodies of almost infinite smallness, yields its energy—perhaps the source of all energy throughout stellar space—for the benefit of those who acquire knowledge of its properties. How different we are from man of only yester-century! Comparatively we know so much more; but actually so little.

WHAT countless millions have died through ignorance in past centuries! But what a pity they are still dying through prejudice, for even today there are persons who are jealous of the powers of radiant energy.

Then there are also those ever-existent quacks who pretend to know more than actually is known. Thus we find, as always, diligent scientific workers battling on one front against the cowardice of prejudice and on the other against the valor of ignorance.

In the field of colored light there is opportunity for the honest and the dishonest, the scientist and the quack. A famous royal prince was cured of smallpox without pitting by keeping him under red light. Naturally the unthinking drew a positive conclusion to the effect that red light was efficacious. As a matter of fact, it was the absence of the other radiation and not the presence of red light that achieved the result. Darkness would have sufficed in this case as well as in the photographic darkroom, but red light is better because it has no influence either way and enables those present to see.

Up to the present time we have little knowledge of the biological or physiological effects of colored lights on the human body. However, we do have some knowledge of the psychophysiological effects of light and color entering our lives through the doorway of vision. Here again, we find the valor of ignorance doing business, but fortunately serious damage is confined to the purse of the unwary.

WHILE scientists are unraveling the tangled skein, all of us can utilize color to some extent by adding variety to the drabness of every-day life. The emotive value of color is not as strong as that of music, but it is just as real. A little music daily is good for us, but we could not enjoy continuously a symphony concert or a Wagnerian opera. So it is with color. Exposure to colorfulness each day is a bit of variety the effect of which is similar to music, and this effect is confined not merely to appreciation of the beautiful, but has a deeper influence upon our minds, our emotions, and consequently our health and happiness.

ERNEST BADE, Ph.D., who in previous articles in POPULAR SCIENCE MONTHLY has given practical hints for planting and caring for your garden, will tell in an early issue how to harvest your crop and store your products for the winter.

KESTER METAL MENDER

It's a Genuine Solder

Simple to Use
Requires Only Heat

HOUSEWIVES
A simple, practical mender for metal ware in the home

HOMETINKERS
Need will develop from roof to cellar

SCHOOL BOYS
For mending and making toys

MOTORISTS
For repairs on the road or at home

SPORTSMEN
Keep a can in your kit—you'll have need for it

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For use in dairy, garage, household and emergency repairs

If your neighborhood dealer cannot supply you send us—

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Gentlemen: Send me one can Kester Metal Mender for which I enclose 25c in stamps.
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THE FYR-FYTER CO., 404 Fyr-Fyter Bldg., Dayton, O.

How Broadcasting Works

(Continued from page 71)

sounds made near by. The aerial, or "antenna," is a long wire, one end of which is high in the air and the other connected with the ground. Over this the modulated radio waves pass to the ether.

A detailed description of the transmitter cannot be attempted here. Suffice it to say that it is made up of coils of wire, metal plates, insulators, and glass bulbs—its units are technically known as "vacuum tubes," "inductances," "condensers," "transformers," and so on—arranged in such a way that electric current supplied by large generators near by flows back and forth through the coils very rapidly—possibly a million times a second. This oscillating current is the "carrier wave" referred to above. Its speed of vibration and other remarkable properties are due to the vacuum tubes in the transmitter, which are quite the most amazing things in radio.

A VACUUM tube looks like a big electric lamp. Within it is a metal tube called the "plate," which surrounds another tube of wire gauze called the "grid." Within the grid is a filament, just like a lamp filament. If an electric current is permitted to flow through it, this filament becomes white hot. From it then shoot millions of tiny charges of electricity called "electrons." These form a sort of "bridge" between the filament and the plate, over which a current of electricity may pass, but in one direction only.

When an electric current of proper potential is applied to the grid—which you will recall is between filament and plate—the grid acts as a screen, preventing the passage of current from the filament to the plate. In the transmitter, vacuum tubes are so connected that this alternate "ebb and flow" of current is very rapid

Now, this oscillating current, vibrating a million times a second in the transmitter, might be put on the air and picked up by a radio receiver. No one could hear it, though, because the most sensitive human ear is incapable of detecting vibrations of a rate greater than about 8000 a second. Anyway, the vibration of the carrier wave is not speech nor music. Speech, music, and the other sounds that make up "broadcasting" are transmitted by modulation of the carrier wave in this way.

THE performer sings, talks, or plays into a sound-sensitive instrument called a "microphone." This is much like the telephone instrument you talk into. When sound waves strike this instrument, part of it moves in unison with the sound vibrations. These movements cause corresponding variations in electric currents passing from the microphone to the broadcasting transmitter. These are the currents used to modulate the carrier wave and thereby put the broadcasting program "on the air."

The currents as they issue from the microphone, however, are very feeble, and must be magnified greatly before they will affect the powerful carrier wave.

(Continued on page 155)

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How Broadcasting Works

(*Continued from page 154*)

This magnification is accomplished by means of vacuum tubes in a "speech amplifier." The magnified current, reaching the transmitter, causes the carrier wave to vary in exact accordance with the speech or music waves striking the microphone. This modulated current is carried to the aerial, and the program of the broadcasting station travels at the speed of light—186,000 miles a second—to radio listeners at all points of the compass.

In up-to-date broadcasting studios, the program delivered before the microphone is not carried directly to the transmitter, but passes through apparatus in a control room, where an operator checks the quality of the broadcasting.

A similar check is kept by the operator at the transmitter, and in this watchfulness lies the explanation of the uniformly good quality of the programs of the larger broadcasting stations.

MANY of the programs broadcast, of course, are performed outside the studio—in theaters, hotel dining-rooms, lecture halls, baseball parks, and similar places. In these cases the microphone is removed from the studio to the scene where the event to be broadcast is taking place, then connected with the broadcasting station over ordinary telephone lines.

When the radio waves carrying speech or music encounter an aerial, they set up in that wire currents that correspond to the vibrations of the radio waves. Your receiving set picks up those currents and transforms them into audible sounds by a process that will be explained in a later article.

The next time you use your radio set, try to visualize these various processes of broadcasting as the programs sound in your head phones. You will probably find your enjoyment of radio greatly enhanced thereby, and a knowledge of these few fundamental facts regarding radio will supply you with the groundwork upon which to build a really expert knowledge of this marvelous new art.

NEXT month's article will carry the story of radio waves from the aerial of the broadcasting station to the head phones or loudspeaker of your receiver.

Recent Publications

Shanks' Mare, by Charles Coleman Stoddard. Sets forth the recreational value as well as the charm of walking in city or country, with practical hints on how to dress for all kinds of weather. George H. Doran Company.

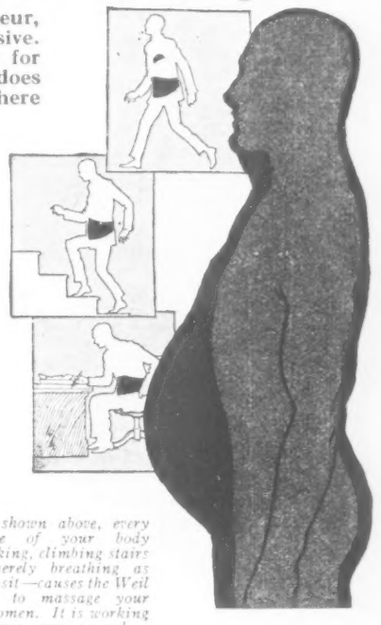
ZR Wins, by Lieutenant-Commander Fitzhugh Green, U.S.N. A thrilling novel of adventure in the Far North, describing an airship voyage to the "*Lost Polar Continent*," of which Commander Green wrote recently in POPULAR SCIENCE MONTHLY. D. Appleton & Co.

Making of Man, by Sir Oliver Lodge, F.R.S. A study in evolution. George H. Doran Company.

The Common Sense of Health, by Stanley M. Rinehart, M.D. George H. Doran Company.

New Self-Massaging Belt Reduces Waist—*Easily!*

Produces same results as an expert masseur, but far quicker, easier and less expensive. Substitutes good, solid, normal tissue for that bulky, useless disfiguring fat, yet does it so gently that you hardly know it is there



As shown above, every move of your body walking, climbing stairs—merely breathing as you sit—causes the Weil Belt to massage your abdomen. It is working for you every second.

Science has found a delightfully easy way to quickly remove fat and obtain a normal waistline—without straining your heart with violent gymnastics or weakening your system by starving. Formerly those who wished to reduce without dieting or strenuous exercise had to go to a professional masseur. His method effectively dislodged the fat and brought about the desired reduction. But it was expensive and time-consuming, and so few could take advantage of it.

Remarkable New Invention

But now a wonderful new invention brings this same effective method within the reach of all. The Weil Scientific Reducing Belt uses this same massage principle, acting by means of its specially prepared and scientifically fitted rubber. It is so constructed that as you wear it, every breath you take and every movement you make imparts a constant gentle massage to every inch of the abdomen. Working for you this way every second, day and night, it reduces much more rapidly than ordinary massage, saving both time and money.

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It does not merely draw in your waist and make you appear thinner. It actually takes off the fat. Within a few weeks you find 4 to 6 inches gone from your waistline. At the same time all your stomach disorders, constipation, backaches and shortness of breath disappear as the sagging internal organs are put back in normal place. Man or woman, you are filled with a wonderful new energy, and both look and feel 10 to 15 years younger.

The Weil Belt is used by hundreds of professional athletes and jockeys because it not only reduces quickly, but at the same time preserves their strength. Highly endorsed for its healthful principles by physicians everywhere. Satisfaction guaranteed or your money back without question.

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Keeping Your Car Free of Carbon

(*Continued from page 83*)

there are no loose, badly fitting, or broken piston rings. Next, see that your oil supply is correct. There should be just enough—every car has a gage that makes it simple to determine that—and it should be of the right quality.

Next, make sure that the carburetor is adjusted correctly. A too rich mixture is about the quickest and surest way of clogging your cylinders with carbon.

As a last measure, take care how you drive. Long trips and steady driving with an even, economical feeding of gas, will not cause carbon to form in excessive quantities if the motor is in good mechanical condition. On the other hand, short trips and frequent starting and stopping cause carbon to form rapidly.

WHEN your motor is idling, it is likely that carbon is being deposited in the cylinders, especially if you have the bad habit of choking the motor almost until it smokes in order to cause it to idle slowly. Another bad habit is "racing" the motor by suddenly opening the throttle while it is idling. This is a certain way of filling your combustion chambers with carbon, for when you open the throttle suddenly, you introduce a charge of gasoline too great to be consumed, and the residue always will be—carbon.

If your motor misses, the cause often will be found in carbon-fouled spark plugs. This condition should be remedied at once, for every time a cylinder misses it becomes filled with gasoline and oil, and, when it does fire at last, this accumulation will turn rapidly to carbon.

Clean spark plugs with the spark gaps properly adjusted are necessary to the proper operation of your car. Many persons make the mistake of assuming that a wide spark gap results in a better spark. This is not so. The spark gap should be between .02 and .025 of an inch, and if you expect your motor to run evenly, every spark plug should have exactly the same adjustment. The best way to assure this is by means of a gage that you can buy for a few cents.

MANY drivers make the mistake of adjusting the spark gaps to the width of a "thin dime." A new dime is .05 of an inch thick, and one on which the figures are barely visible is .04 inch. Either of these measurements is too wide. If you haven't a gage, you can come closer to the proper spark-gap adjustment by using a postal card. A postal card is almost exactly .01 inch thick. Two of them are .02 inch thick, exactly the correct width of a spark gap.

If you will exercise a little care about these things, I can promise you that your carbon troubles soon will be over. You'll have a car that will cost you less money in gas, will be more satisfactory to drive, and will take you past other cars on the hills.

NEXT month—How to detect and trace your automobile troubles from warning noises given by your car.

How to Build a Super-Heterodyne Set

(*Continued from page 68*)

Next, start a wire at terminal *F* of transformer 59, connect it with terminal *F* of transformer 58, bend it toward the panel, until it reaches a point about three-quarters of an inch from condenser 43, then bend it toward the right and bend again at a point directly in front of the *C* terminal of potentiometer 42. Terminate the wire at the *C* terminal of potentiometer 42, soldering the end to the terminal.

The *A* terminal of condenser 43, the *A* terminal of condenser 49, and the inside end, *I*, of coil 52 all are connected with the wire just mentioned by short pieces of wire.

The *F* terminal of transformer 60 is connected with the positive A-battery lead that connects terminal 41 with terminal 48.

Terminal *P* of socket 57 is connected with terminal 46.

THE internal wiring is completed by joining, in the order named, the *B* terminals of transformers 58, 59, and 60 and terminal 63.

All that remains is to solder leads to terminals 53 and 63 for connection with the B batteries. The lengths, of course, will depend on the distance from the set to the batteries.

If you have wired units numbers 1 and 3 in accordance with the instructions given in last month's issue, and have not changed the wiring so as to enable you to use units 1 and 3 together as a simple honeycomb coil receiver, you are ready to connect the three units together and enjoy the programs that the super-heterodyne will get for you. If you changed the wiring, change it back to its original form.

You are now ready to connect the units together.

One end of the loop aerial, consisting of about 10 turns wound on a two-foot frame, is connected with post 1, and the other end with post 2 of unit 1.

The negative A-battery lead is connected with terminal 3, and the positive A-battery lead with terminal 4 of unit 1.

Arrange the units as shown in the front view of the completed receiver and make the following connections: Connect terminals 21, 22, and 23 of unit 1 with terminals 39, 40, and 41,respectively, of unit 2. Then connect terminals 46, 47, and 48 of unit 2 with terminals 24, 25, and 26, respectively, of unit 3.

IN a receiver of this type, using so many tubes, the low consumption types of tubes should be used. A B battery of 90 volts usually is sufficient for all purposes.

Terminal 9 of unit 1 is connected with the negative terminal of the B battery. Terminal 12 of the same unit is connected with the highest B-battery voltage.

Terminal 53 of unit 2 is connected with a voltage not higher than 22½ volts if a soft tube is used. If a hard tube is used, it may be connected with voltages of from 45 to 90 volts. The same con-

(*Continued on page 158*)

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Short Wave Coupler
(Oscillator Coupler)

Gives a uniform output at any frequency from 150 meters to 650 meters. Housed in a bakelite case (exactly like Type R-120) effectively protecting it from injury.

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Built to pass an intermediate frequency of 30 kilocycles, together with side-band (26 to 34 kilocycles); other frequencies effectively dropped out. Beautiful bakelite housing.

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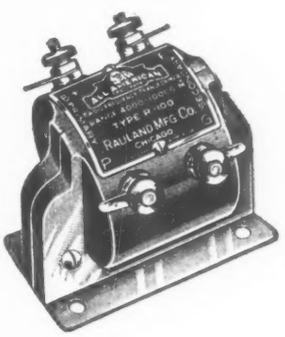

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Provides maximum amplification at 30 kilocycles, as well as at other intermediate frequencies in standard use, from 15 to 75 kilocycles (4,000 to 20,000 meters).

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In a word, the All-American you bought two years ago, unsurpassed as it was at that time, is overshadowed in quality of performance by the All-American of the present day as the strength of a child is exceeded by that of a grown man.

Continuing, without radical change, the present standard All-American models (Audio, Power, Long-Wave) we shall announce, during the months of October and November, achievement in the art of transformer building, surprising in their far-reaching importance even to those long familiar with All-American superiorities.

The Radio Key Book is Out—*You'll be surprised! If you haven't ordered yours, send 10 cents, coin or stamps.*

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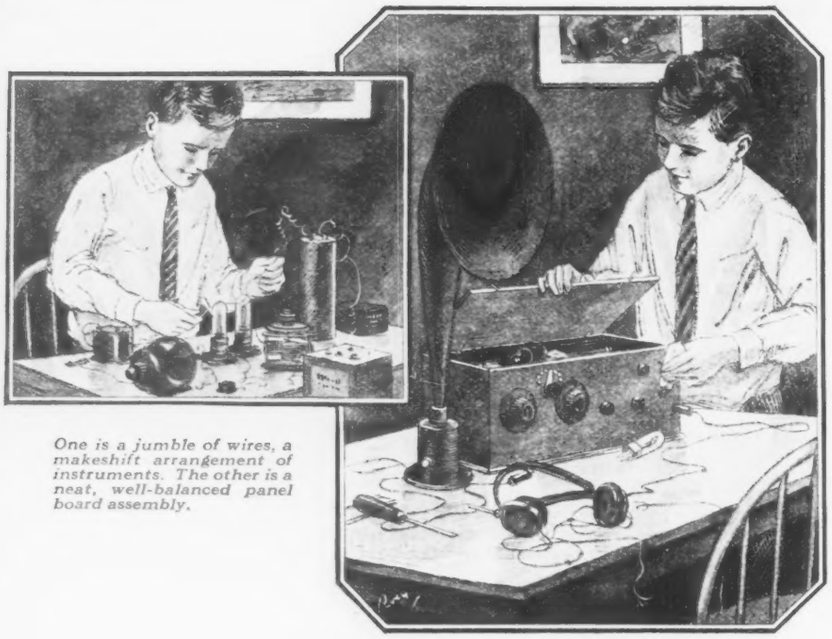

One is a jumble of wires, a makeshift arrangement of instruments. The other is a neat, well-balanced panel board assembly.

Is your radio set a "potato patch"?

The "potato patch" set is neither attractive in appearance nor efficient in operation. It is simply a jumble of wires and instruments.

Fine instruments should be mounted on a first-class panel. Use a good bakelite panel, preferably Celoron. Arrange your instruments properly on a Celoron panel and you begin your radio career with one less obstacle to clear reception.

Celoron is one of the finest insulating materials known. It possesses high dielectric strength and the ability to resist atmospheric attacks.

It never chips, cracks, warps, or buckles. It is practically indestructible.

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OZARKA, INC.
21 N. Peoria St., CHICAGO, ILL.

How to Build a Super-Heterodyne Set

(*Continued from page 157*)

ditions apply to terminal 32 of unit 3.

Terminal 63 of unit 2 is connected with a voltage of from 45 to 90 volts, while terminal 38 of unit 3 is connected with the highest value voltage of the B battery.

Enclosing each unit in a separate cabinet the inside walls of which have been covered with tinfoil or other such material used for purposes of shielding will increase the selectivity of the set, but such shielding is not absolutely necessary. While shielding increases the selectivity, it has a tendency to cut down the sensitivity and signal strength.

The super-heterodyne receiver is fairly simple to operate after a little practice. Once a station is tuned in, the readings of the two condenser dials can be recorded so that when you desire to listen to that station again, the settings can be adjusted almost instantly.

In tuning the set for the first time, begin by setting the tuning condenser 16 at zero, then vary the oscillator condenser through its range. While doing this, the slider arm of the potentiometer should be set about a quarter of a revolution from the negative terminal *A* of of the potentiometer.

When trying for near-by stations, the setting of the tuning condenser 16 can be changed about 10 degrees at a time, and the oscillator condenser may be turned through its entire range as before. For more distant stations a closer adjustment is required, and the tuning condenser should be turned through five degrees or less at a time.

When once obtained, the signal can be cleared up and strengthened by finer adjustments of the two condensers by means of the Vernier attachments and by adjustment of the potentiometer.

DO not try making any changes in the wiring until after you have tried the set for two or three evenings and have acquired the knack of handling it.

If after that time you still experience any difficulty due to use of parts of a different type than were used in making this set, try using different values of capacity in condensers 49 and 50, or disconnect them entirely. Do the same with condensers 8, 34, and 43, and with grid leaks 18 and 62.

If the set works all right up to the second detector stage but you have trouble when switching to the audio amplifier stages, try the effect of changing your tuning slightly when changing to the amplifier stages. Also try using condensers of from .00025 to .006 across the primary and secondary windings of the audio transformers, and connecting grid leaks of from ¼ to 10 meghoms across the secondary windings of the audio frequency transformers.

When properly adjusted and operated, you should have no trouble in pulling in stations 1000 and more miles away on a loudspeaker with a loop aerial.

The use of the set with a large outside aerial is not advisable. It can be used, however, with a small indoor aerial by

(*Continued on page 159*)

How to Build a Super-Heterodyne Set

(*Continued from page 158*)

plugging a honeycomb coil of the proper size for the station to be received into mounting 11 of unit 1.

Very good results can be obtained also by using no aerial whatsoever, but connecting the ground wire with aerial post 1 of unit 1. In that case a honeycomb coil of the proper size should be plugged into coil mounting 11.

In an article next month, Milton B. Sleeper, one of America's foremost radio engineers, will tell you how to build a short-wave receiving set.

Here Are Correct Answers to Questions on Page 78

1. There are about 520 of them that have to do with the moving of the body.

2. It is made up of our sun and the planets that revolve about it. There are eight planets: Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Neptune, and Uranus.

3. They are not only the particles inside of atoms, but the smallest known particles of electricity. An electric current is merely a stream of electrons passing through a wire.

4. So that the bridge shall not be set into vibration by the regular and repeated tap of the falling feet. Sometimes this makes bridges sway in time with the feet and this may strain their ironwork structure.

5. Yes, exactly; though the ice occupies a little larger volume.

6. Soil is rock that has been broken up and altered chemically by the weather, and that contains more or less organic matter left in it by plants that have grown there and died.

7. Because copper carries the stream of electrons with less resistance. A copper wire will carry about six times as much current as an iron wire of the same size.

8. It is a way of expressing how fast energy is being used. One horsepower equals 746 watts of electricity, about 15 times as much current as is burned by an ordinary lamp.

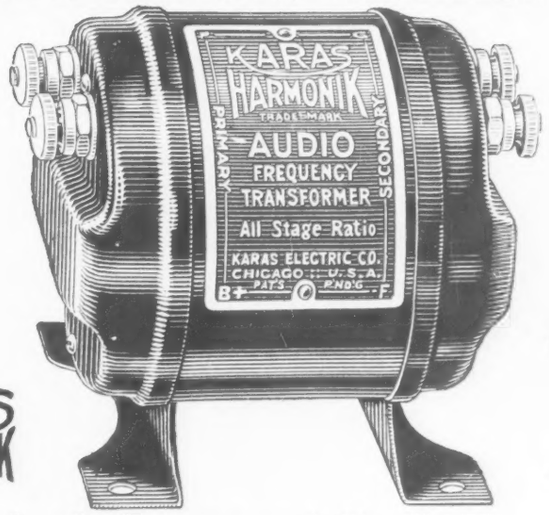
9. In primitive man and lower animals they doubtless served the purpose of keeping insects from crawling into the eye during sleep. They still serve to some extent the purpose of keeping things out of the eyes.

10. Because gasoline is more easily vaporized. The air all around it gets full of gasoline vapor and this makes an explosive mixture. Kerosene gives off very little vapor, so this does not happen with it.

11. Alcohol paralyzes the muscles that move the eyeballs, so that the two eyes no longer point in exactly the same direction. This means that the brain gets two sight messages of the same object, one from each eye.

12. So far as we know they do not, though it is possible that the playful chatter of some of the higher apes is an equivalent of our laughter.

Marvelous New Transformer



KARAS HARMONIK TRADE MARK

$7.00

Our Slogan "The Best Transformer Money Can Buy"

Amazingly Improved Radio Reception *Or* Your Money Back

UNLESS you can enthusiastically say: "I have never heard a radio give forth such pure, full, rich, round, pleasingly natural tones" we will promptly return the money you pay us for a pair of KARAS HARMONIK Transformers.

That's our special introductory offer! You are both Judge and Jury.

You will agree that the only criticism of radio reception at the present time is that the full beauty of music is lacking owing to the failure or inability of radio sets to reproduce and amplify the rich overtones and harmonics of sounds which are so necessary to really TRUE music. Up to now we have been receiving only a small part of musical tones—that's why voice and musical instruments sound so unnatural in a radio set. The NEW KARAS HARMONIK Transformers have changed all this by reproducing and fully amplifying entire tones—the harmonics and overtones equally with fundamental or primary tones.

You want the most perfect tone quality a radio set can possibly give you. So does everybody else. You want reception from a piano to sound like beautiful full toned piano music—not like the thin, stringy tones of a banjo. The new Karas Harmonik Transformers will give you such an unbelievable volume of delightfully pure music that you will be enthusiastically surprised.

You say "Prove this to me and *of course* I'll use your Transformers". To prove it to your entire satisfaction is exactly what we propose to do by our unconditional money-back guarantee.

Over a year ago our Engineers set out to design and develop an Audio Frequency Transformer that would raise the quality of radio music and speech to an entirely new plane. It has taken a year of intensive hard work and the expenditure of many thousands of dollars to do this. But now the new KARAS HARMONIK Transformer is a reality and available for you to use and enjoy.

Our transformers are being sold through regular jobber and dealer channels but it takes time to effect complete national distribution. If your dealer has our New Karas Harmonik Transformers in stock he is authorized to extend our offer to you. If he hasn't yet had a chance to secure a supply, you may order direct from us in accordance with our special introductory offer backed by an unconditional guarantee that enables you to try out and prove these new KARAS HARMONIK Transformers without risking one penny.

Here's the Offer We Make You

Just fill in and mail the coupon below and we will send you a pair of the new Karas Harmonik Audio frequency Transformers to take the place of the Transformers now in your set or put in that new set you are building or are going to build.

When the Transformers arrive you hand the postman $7.00 for each Transformer plus a few cents postage. Put the Transformers into your set and use them for 60 days. Put them to every test you can devise. Then if you do not decide that the quality of musical reception of your set is vastly improved you are free to return the Transformers and we will cheerfully return your money immediately without question or quibble.

KARAS ELECTRIC CO., 4040 N. ROCKWELL ST. DEPT. 13-67 CHICAGO

To Jobbers and Dealers.
Distribution of Karas Harmonik Transformers through regular jobber and dealer channels is being carried out as rapidly as the output of our factory permits. In the meantime mail applications will be taken care of in the order they are received, on an allotment basis. Write us for test records, discounts, etc.

To Set Manufacturers.
We positively prove that Karas Harmonik Transformers will vastly improve the musical quality of your set by any form of test you wish to impose. When you are convinced of this you will naturally want to use them. Write or wire us and arrangements for tests will be made promptly.

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Please send me .....pair of Karas Harmonik All Stage Ratio Audio Frequency Transformers. I will pay the postman $7 a piece, plus postage, on delivery. It is understood that I am privileged to return the transformers any time within 60 days if they do not prove entirely satisfactory to me, and my money will be refunded at once.

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May Be Used In Connection With Any Receiving Set
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1 Thordarson or Columbia Low-ratio Transformer.
2 Bakelite Rheostats.
2 Bakelite Sockets.
2 2-circuit Jacks.
1 1-circuit Jack.
1 Baseboard.
9 Binding Posts.
$10.90
Diagram and Instructions for wiring.

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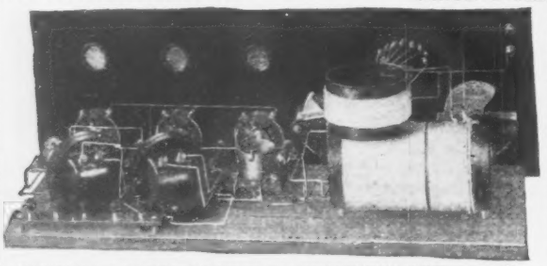
Genuine Hazeltine Licensed Fada, Freed-Eiseman, or other Genuine Licensed Parts
1 7x28x⅜ Drilled Panel.
2 All American or Columbia Audio Transformers.
3 4" Bakelite Dials.
3 Filament Control Jacks.
1 Vernier Rheostat—30-ohm.
1 Plain Rheostat—6-ohm.
1 strip Bakelite, 6x1x⅜.
PARTS FOR 5-TUBE SET:
8 Binding Posts.
1 Grid Leak and Condenser.
2 Bakelite Sockets.
1 .001 Condenser.
1 Dubilier By-Pass Condenser.
3-Gang Bakelite Socket.
35 feet Hook-up Wire.
1 Wave Control Neutroformer.
2 R. F. Neutroformers.
1 Baseboard.
2 Neutrodons
3 Bezels.
Complete blue-prints and working diagrams and instructions.
5-TUBE SET $43.75
PRICE—3-Tube Set, $26.45



SUPER Heterodyne
Containing 3 Intermediate Frequency Transformers, Filter Transformer, Oscillator Coil and 2—1 M. F. Condensers.
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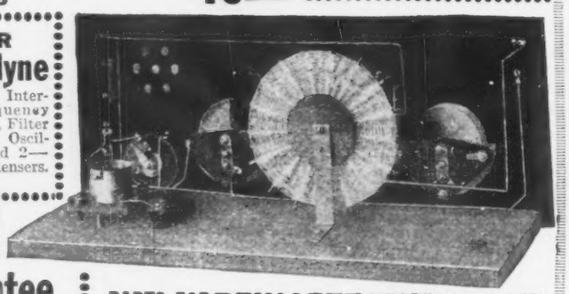
with Audio frequency Trans. $26.65



COMPLETE PARTS FOR 3-TUBE **COCKADAY RECEIVING SET**
1 Cockaday Coil.
2 23-plate Hy-Grade Cond.
1 Bakelite Rheostat, 30-ohm.
1 Bakelite Rheostat, 6-ohm.
3 Bakelite Sockets.
1 high ratio Columbia or All-American Transformer.
1 Single Circuit Jack.
1 low ratio Columbia or All-American Transformer.
2 Double Circuit Jacks.
2 3" Bakelite Dials.
1 Grid Leak and Mica Cond.
7 Switch Points. 2 stops.
1 Bakelite Binding Post Strip.
8 Binding Posts.
1 7x21x⅜" Drilled Bakelite Panel.
3 Bezels.
1 Baseboard.
Complete blue-prints and wiring diagrams.
3-TUBE SET $19.95
1-Tube Set.....$10.45

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1 7x18 Bakelite Panel.
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1 Bakelite Socket.
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1 11-plate Lo-loss Var. Cond.
2 Bakelite Dials.
1 Genuine Rheinartz Coil
2 doz. Switch Points and Stops.
3 Switch Levers.
25 feet Busbar Wire.
1 Freshman Grid Leak and Condenser.
1 Baseboard.
9 Binding Posts.
Blue-print and Complete Instructions.
1-TUBE SET $10.45
3-Tube Set.....$17.55

Complete Parts for **ACME 4-TUBE REFLEX**
3 Acme A-2 Transformers
1 Acme R-2 Transformer
1 Acme R-3 Transformer
1 Acme R-4 Transformer
4 Bakelite Tube Sockets
1 Duplex or Bremer-Tully Lo-loss 23-plate Condenser.
1 Frost Potentiometer-Rheostat.
1 .00025 Fixed Condenser with grid leak mounting.
1 .0025 Fixed Condenser.
2 .002 Fixed Condensers.
1 .005 Fixed Condenser.
1 RW Crystal Detector.
8 Binding Posts.
1 3" Bakelite Dial.
1 2-circuit Phone Jack.
1 length Spaghetti.
25' No. 14 Hook-up Wire.
1 50,000-ohm Grid Leak.
1 "C" Battery.
1 7x21x⅜" Bakelite Panel —drilled.
1 Baseboard.
Complete set blue-prints and instructions for wiring.
4-Tube Set $39.85
1-Tube Set.....$17.45

COMPLETE PARTS FOR 8-TUBE **SUPER-HETERODYNE**
1 23-plate Lo-loss Vernier Bremer Tully or Duplex Condenser.
1 23-plate Lo-loss Vernier Bremer-Tully or Duplex Condenser.
1 465-ohm Frost Potentiometer.
2 6-ohm Rheostats.
2 30-ohm Bakelite Rheostats.
1 .00025 Fixed Condenser.
4 .002 Condensers.
1 .006 Condenser.
1 Bakelite Terminal Strip for Binding Posts.
1 Multicolucord Cable for connecting batteries.
1 1-Meg. Leak.
2 4" Bakelite Dials.
1 Single Circuit Jack.
2 2-Circuit Jacks.
8 x 35 Baseboard.
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3 All-American or Columbia Long-wave Transformers.
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